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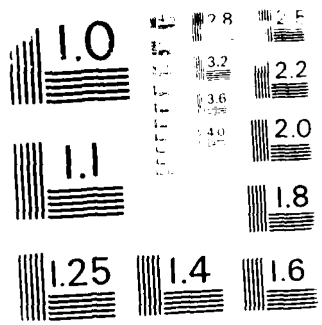
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DCN 87-212-027-27-01

INSTALLATION RESTORATION PROGRAM
PHASE II - CONFIRMATION/QUANTIFICATION
STAGE 1

FINAL REPORT
FOR
AIR FORCE PLANT 4
FORT WORTH, TEXAS

VOLUME 9. APPENDICES F-K

HEADQUARTERS AERONAUTICAL SYSTEMS DIVISION
FACILITIES MANAGEMENT DIVISION (ASD/PMDA)
WRIGHT-PATTERSON AIR FORCE BASE, OHIO 45433-6503

AND

HEADQUARTERS, AIR FORCE SYSTEMS COMMAND
COMMAND BIOENVIRONMENTAL ENGINEER (AFSC/SGPB)
ANDREWS AIR FORCE BASE, DC 20334-5000

DECEMBER 1987

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APPENDIX F

Sampling and Analytical Procedures

- Field Investigation Quality Control Plan
- Quality Assurance/Quality Control Program for Radian Analytical Services

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Field Investigation Quality Control Plan

A Quality Control plan for the field investigation conducted at U.S. Air Force Plant No. 4 is included in the Technical Operations Plan, Appendix K.

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THE QUALITY ASSURANCE/QUALITY CONTROL PROGRAM
FOR RADIAN ANALYTICAL SERVICES

Radian Analytical Services' (RAS) objective is to provide high quality chemical analyses to all clients regardless of the size of the analytical task. To aid in achieving this goal, a strong quality assurance program and rigid quality control practices are integral parts of all analyses. This document describes these quality assurance/quality control protocols for the Radian Analytical Services laboratories.

The basic quality control program includes procedures for sample handling, calibration, spiking and replicate analyses, analysis of QC test samples, equipment maintenance, and supplies control. These procedures can be integrated with a client's additional requirements, such as spiking studies, analysis of replicate samples, linearity determinations, and stability studies.

The quality assurance program consists of the frequent submission of blind QA samples, duplicates, and spiked sample splits. Also included are personnel training, analytical methodologies, sample control procedures, data handling, and equipment maintenance and calibrations.

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1.0 QA Organization/Policy

The objective of Radian's quality assurance/quality control program is to assure, assess, and document the precision, accuracy, and adequacy of data obtained from chemical analysis and to assure the technical accuracy of the results obtained for all samples.

Radian has organized the quality assurance function within the company to allow complete independence of program review. Radian's Quality Assurance Director reports directly to the Vice President of the Technical Staff. This position provides independent reviews at all levels of the technical staff and laboratory organization and allows immediate access to Radian's top management on QA-related matters.

The QA Director's involvement may be limited to a review of quality control practices or as extensive as active development and implementation of quality control procedures and statistical data analysis. The QA Director may be asked to contribute expertise and assistance when a need is perceived by either the client, the technical staff, or the management staff.

Because of the large number of samples analyzed by RAS, a QA coordinator has been assigned to monitor and maintain an effective QA/QC program for these laboratories. The RAS Quality Assurance Coordinator, directly responsible to the Corporate QA Director, serves as an independent auditor of all RAS laboratories. The responsibilities of the RAS QA Coordinator are as follows:

- Monitor QA/QC within RAS laboratories,
- Supervise the preparation of blind audit samples,

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- inform the Director of RAS and the corporate QA Director of quality assurance problems,

- summarize and report QA activities in the laboratories,

- document all QA and QC procedures within RAS,

- act as liaison between the corporate QA Director and RAS,

- provide QA data to the corporate QA Director for inclusion in the corporate QA reports.

The RAS laboratory managers function as the quality control coordinators in each particular analytical area. Their efforts are coordinated and monitored by the QA Coordinator.

Quality control coordinators serve as a focal point for all QC activities pertaining to each RAS laboratory. They work as a committee coordinated by the RAS Quality Assurance Coordinator. Their activities include the following:

- monitor the QA/QC activities of the laboratory area,

- inform the Director of Analytical Services and the QA coordinator of QC problems and needs.

- summarize, document, and report quality control activities and data generated in the laboratory,

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- provide documentation of all QC procedures in the laboratory,

- maintains summaries of QC activities and data in a form suitable for client review upon request.

2.0 Quality Control for Laboratory Analyses

Radian Analytical Services has developed and implemented quality control procedures for all of the analyses performed in the laboratory. The laboratory quality control program provides an effective and efficient laboratory protocol for QC regardless of the size or scope of the analytical requirements. Approved analytical methods are used whenever available. When approved methods are not available, a method is developed by the Radian technical staff, and a technical note written describing the method. The quality control procedures are designed to insure that the standard operating procedures and quality control protocols are being followed and accurate results are obtained.

The general quality control program utilized in each laboratory includes consideration of the following areas:

- personnel training and certification,
- analytical methodology documentation,
- sample handling and control,
- laboratory facilities and equipment,
- calibration and standards,
- data handling and documentation,
- quality control check samples,

The general approach to quality control in each of these areas is discussed in the remainder of this section.

2.1 Personnel Training and Certification

The successful implementation of any QA/QC program is determined by the training and dedication of the laboratory personnel. The quality and consistency of data should be independent of the analyst. With the proper training and supervision, an analyst will be able to obtain quality data by the use of proven methodology. Periodic assessment of training requirements and certification are performed to maintain a high level of laboratory awareness.

The training and certification methods employed in the RAS laboratories are briefly described below:

- study of laboratory standard operating procedures,
- study of QA manual,
- observation of experienced operators/analysts,
- study of operating manuals,
- instruction by the laboratory manager on all aspects of the analysis,
- perform the analysis under the direct supervision of the laboratory manager,
- perform analysis under supervision of experienced personnel,
- analysis of blind QC samples prepared by laboratory QC coordinator,
- participation in in-house seminars on laboratory methods and procedures.

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PERSONNEL TRAINING RECORD

Employee ____________________

Employee Number ____________________

Date of Employment ____________________

Laboratory Orientation:

Upon completion of each phase of personnel training the employee and Laboratory Manager will initial and date the step completed.

- The RAS laboratory Standard Operating Procedures have been read and understood.

  ________ Employee ________ Lab Mgr. ________ Date

- The RAS Quality Assurance manual has been read and the procedures for the laboratory in which the employee worker have been explained.

  ________ Employee ________ Lab Mgr. ________ Date

- Operation manuals for instruments with which the employee performs analyses have been studied and the procedures for operation and maintenance are understood.

Instrument	Employee	Lab Mgr.	Date	Instrument	Employee	Lab Mgr.	Date

Figure 2-1.

Test Specific Training:

Each specific test performed in the RAS laboratories involves procedures which may be unique. The steps involved in training an employee are:

- Instruction by the Laboratory Manager on all aspects of the analysis,
- Observation of experienced operators/analysts,
- Perform the analysis under supervision of the laboratory manager,
- Perform analysis of QA samples submitted by the QA coordinator, and
- Participation in in-house seminars on laboratory methods and procedures.

The following table is to be completed by dating and initialing by the employee and Laboratory Manager upon completion of each step.

Method	Instruction	Observation	Perform the Analysis	Analysis of QA samples	Seminars

Figure 2-1. (Cont'd)

All RAS personnel must complete a quality control training program. This system includes motivation toward producing data of acceptable quality and involves "practice work" by new employees. New personnel are made aware of the quality standards established by RAS and the reasons for those standards. They are made aware of the various ways of achieving and maintaining quality data. After an employee has been trained to use a method and the work validated by the laboratory manager, the employee is certified to perform the analysis. As these people progress to higher degrees of proficiency, their accomplishments are reviewed and then documented. Documentation of proficiency training is maintained by the QC Coordinator for each laboratory technician using the two-page form shown in Figure 2-1.

2.2 Analytical Methodologies

All analytical procedures followed in the RAS laboratories are documented in a methods manual for the specific laboratory. A set of standard operating procedures (SOP) has been established for each analysis to insure consistency. Most methods used are directly from an approved analytical manual, e.g., EPA methods, APHA Standard Methods for Water and Wastewater, ASTM, etc.

Methodologies may contain the following information:

- method title,
- scope of method,
- summary of interferences, and applications,
- concentration ranges and detection limits,
- safety precautions,
- required equipment and materials,
- standardization directions,
- detailed analytical procedure,
- calculations, with examples,
- reporting method,
- precision and accuracy statement,
- references.

2.3 Sample Control and Record Keeping

The Radian Analytical Services Sample Control Center is a controlled access area. Only employees of the Sample Control Center have access to sample receiving, sample storage, documentation files, and the computer terminals. Analysts check out samples under the supervision of the sample control personnel. All samples are stored in locked storage areas. Sample tracking is maintained by a computerized laboratory management system and a sample checkout logbook. The RAS Sacramento laboratory is linked to the central processing unit of the computer in Austin via a dedicated phone line. This insures that the laboratories are in constant communication. All sample information and data entries can be immediately accessed at either location.

Detailed record keeping and control of samples are essential for effective laboratory operation. All samples received for analysis in the Radian Analytical Service laboratories are processed through the Sample and Analysis Management System (SAM). Radian Corporation's SAM is a software and hardware system for controlling and handling information for the analytical laboratory. SAM provides a dynamic, easy-to-use method for tracking, scheduling, reporting, and laboratory management. The system has been designed to accommodate and promote good laboratory management practices by providing high visibility of the information laboratory managers need to make good decisions regarding schedules and priority. The system is designed around a Data General Nova-IV computer with a 64K-byte memory. It also includes a 65M-byte disk drive and a line printer with plotting capabilities. Data is entered via a TEC terminal and CRT. All data stored on the disk is backed up on magnetic tape to prevent loss in the event of a system malfunction. The system is designed so that an individual designated as the principal operator can process the required paperwork for a large laboratory with little difficulty. The approach centralizes information input and data retrieval, and provides the mechanism for organized, up-to-date laboratory performance monitoring.

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SAM maintains complete client information files, generates laboratory status reports, flags sample analyses which are overdue, accepts analysis results manually or automatically, and generates reports and invoices.

The Sample Control Center and SAM have six basic functions:

- sample receipt and logging,
- sample storage and maintenance of sample integrity,
- laboratory status reporting,
- document control,
- data compilation and reporting, and
- invoicing

In order to assure the integrity of a sample and the accompanying documentation, a security plan has been established. This plan consists of three parts:

- chain or custody,
- secured refrigerated storage, and
- document control.

The progression of samples and documentation through the Sample Control Center and the analytical laboratories is presented in Figure 2-2. Detailed descriptions of each sample control function are presented below:

- Samples are received from the commercial carrier at Radian's shipping and receiving facilities by the receiving clerk.

- Within one hour of arrival, the samples are accepted by RAS sample control personnel.

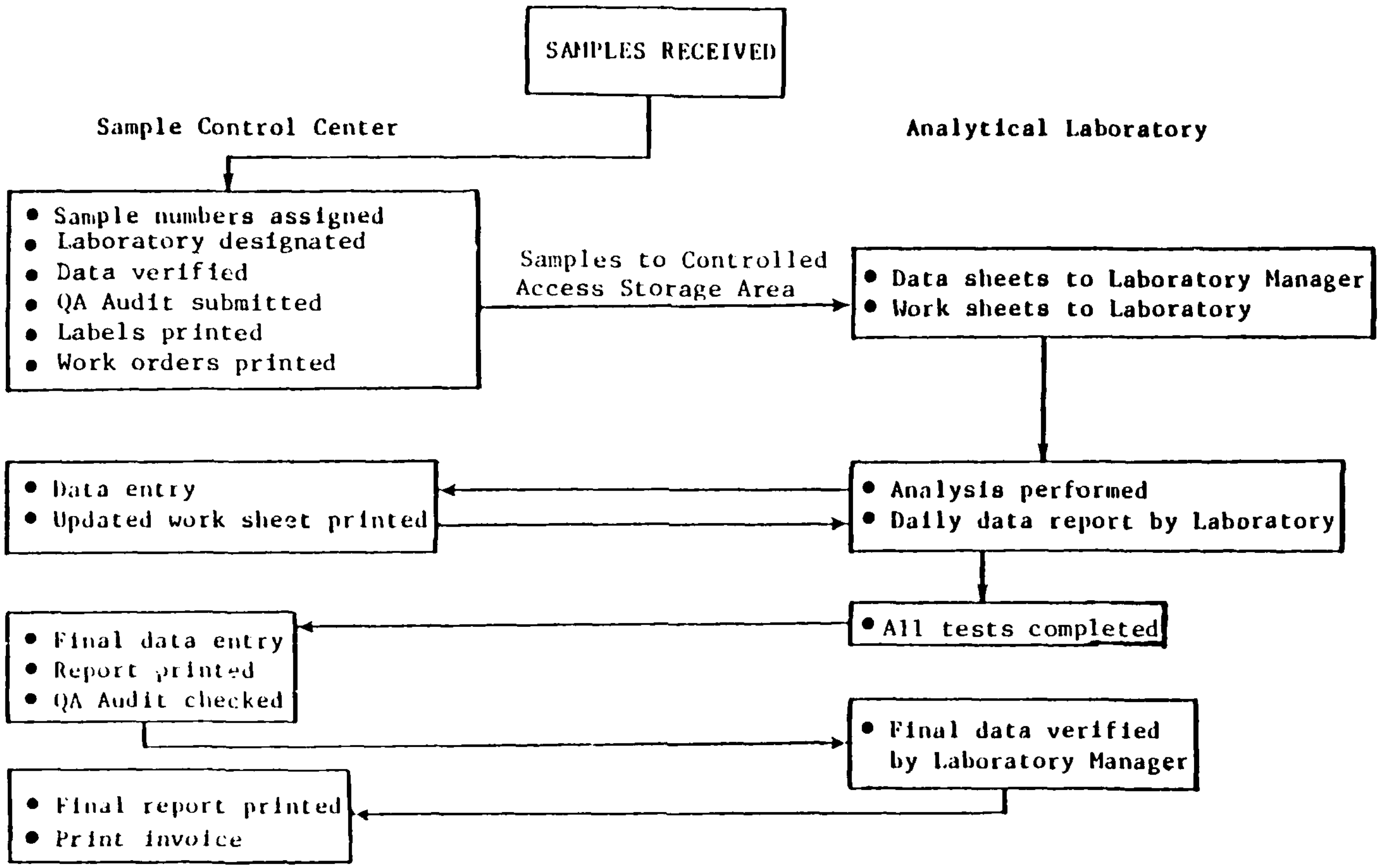

Figure 2-2. SAM Laboratory Management System

- All shipping containers and security seals, when appropriate, are inspected for physical damage or evidence of tampering.

- The samples are unpacked in the sample receiving area by the RAS sample custodian. The method of shipment, shipping container integrity, condition of samples, the number of samples/container, integrity of the security seal, and accompanying documentation are noted. Sample identification is verified against custody documents. The enclosed chain-of-custody forms, Figure 2-3, when required, are completed and filed with the shipping and receiving documentation. In the event that peculiarities are noted, the project officer or client is immediately advised of the irregularity.

- Samples are logged into a bound sample logbook, Figure 2-4. Again, sample identity is verified. All discrepancies are noted in the logbook.

- The handwritten logbook and all documentation are transferred to the Sample Control Center.

- The samples are logged into the SAM system. Each batch of samples is assigned a consecutive work order number by the system. Analytical requirements for each sample are entered into the computer.

- Hard copy of the work order and other information is printed and filed with the received documentation in the Sample Control Center.

- Labels are printed and secured to each sample. Label information includes sample number, identification, storage location, and analytical requirements.

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CHAIN OF CUSTODY RECORD

Field Sample No. ____________

Company Sampled/Address ____________

Sample Point Description ____________

Stream Characteristics:

Temperature ____________ Flow ____________ pH ____________

Visual Observations/Comments ____________

____

Collector's Name ____________ Date/Time Sampled ____________

Amount of Sample Collected ____________

Sample Description ____________

Store at: ☐ Ambient ☐ 5°C ☐ −10°C ☐ Other ____________

☐ Caution - No more sample available ☐ Return unused portion of sample ☐ Discard unused portions

Other Instructions - Special Handling - Hazards ____________

____

____

☐ Hazardous sample (see below) ☐ Non-hazardous sample

☐ Toxic ☐ Skin irritant ☐ Flammable (FP< 40°C)

☐ Pyrophoric ☐ Lachrymator ☐ Shock sensitive

☐ Acidic ☐ Biological ☐ Carcinogenic - suspect

☐ Caustic ☐ Peroxide ☐ Radioactive

☐ Other ____________

Sample Allocation/Chain of Possession:

Organization Name ____________

Received By ____________ Date Received ____________ Time ____________

Transported By ____________ Lab Sample No. ____________

Comments ____________

Inclusive Dates of Possession ____________

Organization Name ____________

Received By ____________ Date Received ____________ Time ____________

Transported By ____________ Lab Sample No. ____________

Comments ____________

Inclusive Dates of Possession ____________

Organization Name ____________

Received By ____________ Date Received ____________ Time ____________

Transported By ____________ Lab Sample No. ____________

Comments ____________

Inclusive Dates of Possession ____________

Figure 2-3. Chain or Custody Record

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Lab No. ________

Company ________
Facility ________
____
Rep ________
Phone ________
Report ________
to ________
____
____
Attn ________
Inv ________
to ________
____
____
Attn ________
P.O. # ________
Expires ________

Quoted $ ________
Sample $ ________
Misc $ ________
Total $ ________
Inv by (CPR) ________
% Surcharge ________
% Disc: All ________

Contact ________
Received ________
Date Due ________
Samples ________
Keep for ________
Keep til ________
Disp (RD) ________

Reports ________ # Invoices ________

Work ID ________
Taken ________
Trans ________
Type ________
Condition ________
Comments:

Location: ________

Dash No.	Sample Description	Analysis Required	QA

Figure 2-4. Sample Log Sheet

- Data sheets and work sheets are printed for each batch of samples and distributed to the appropriate laboratory managers. The work sheets list sample numbers, sample identification, storage location, and analytical requirements. Data sheets are for results and contain only the parameters to be determined by a given laboratory.

- Following sample logging, the samples are placed in the designated locked storage area.

- Subsequent sample custody is documented and all transactions witnessed by sample control personnel.

- The analyst retrieves the samples from the Sample Control Center by sample number and storage location.

- The Sample checkout log (Figure 2-5) is completed by the analyst, noting the laboratory to which the sample is being removed.

- After analysis, or when the required aliquot is removed, the sample is returned to the Sample Control Center and return is noted in the sample checkout log.

- The sample is returned to the designated storage location.

- When requested, addition chain-of-custody documentation can be provided using a SAM-generated document (Figure 2-6). This document can be retained by sample control to provide a more easily retrievable record of sample custody within the analytical laboratory.

- The sample is stored until the assigned time or written permission is given to either properly dispose of or return the sample to the client.

RAS SAMPLE CHECK OUT LOG

WORK ORDER	SPLITS REMOVED	CHECK-OUT INFORMATION				RETURN INFORMATION		
		DATE	TIME	DESTINATION	INITIALS	DATE	TIME	INITIALS

7S/196
(Water and
Prep. Labs)

7S/194
(Extraction
& Water Labs)

7S/180
(ICP and AA
Labs)

7S/191
(TOX, TOC)

7S/195
(Technician)

7S/171
(GC)

Figure 2-5. Sample Checkout Log

RADIAN

PAGE 1 Analytical Serv CHAIN OF CUSTODY LAB # 83-02-A67

RCVD: 02/26/83 DUE: 03/19/83 04/21/83 09:56:49 KEEP: 05/09/83 DISP: D

DASH	SAMPLE IDENTIFICATION	LOCATION	TESTS						
01A-B	Number 001	Ref 2	CAUSTY	CO3_A	HARD_B	HCO3_A	MHO_A	ONG_A	PH_A
			PO4_B	SO3_TA	TANNIN				
02A	Number 002	Ref 2	ACFS						
02B	Number 002	Ref 2	ICP_40						
03A	Super soil	Ref 2	ANFS						
04A	Boiler scale 222	Ref 2	CA_E	CL_TA	CO3_A	FE_E	HCO3_A	MG_E	NA_E
			P_E	SO4_NA	S_E	ZN_E			
05A	Sample AV56	Shelf 13	B_MET	C_MET					
06A	Water #164	Ref. 023	AG_E	AS_HA	BA_E	CD_E	CR_E	FE_E	HG_CA
			MN_E	NA_E	PB_GA	SE_HA			
06B	Water #164	Ref. 023	CL_TA	F_SIEA	MHO_A	NO3_A	PH_A	SO4_NA	TDS_A
06C	Water #164	Ref. 023	H1RCRA	P1RCRA					
06D	Water #164	Ref. 023	ALPHA	BETA	RA_TOT				

RECEIVED BY	DATE	RETURNED TO	DATE	FRACTION NUMBERS.

Figure 2-6. Laboratory Chain of Custody

- All documentation, including shipping documents, field sampling documents, computer-generated log sheets, chain-of-custody forms, laboratory data sheets, final computer reports, and other documents, are maintained in the sample control area. All reports are kept in locked filing cabinets. As with the sample storage area, the document storage area is limited-access.

All storage areas are within the Sample Control Center and are locked when not in use. Access to the storage area is limited to sample control personnel or other RAS employees accompanied by sample control personnel. There are four storage locations that are used depending on the sample and the required analyses. They are:

- ambient storage for samples that do not require refrigeration,

- 4°C storage for most samples requiring water quality analysis and extractable organics,

- 4°C storage for samples requiring volatile organic analysis, and

- -20°C storage for extracts and samples that require freezing.

A temperature log is maintained to monitor the cold storage facilities.

2.4 Laboratory Facilities and Equipment

A clean well-lighted, and well maintained laboratory is essential for accurate analytical results. Each laboratory is well-lighted, air conditioned and equipped with chemical fume hoods. Instrumentation that may emit noxious odors is vented externally.

Quality Control of Equipment and Supplies

Each laboratory QC program includes detailed requirements for equipment and supplies. Reagents, solvents, and standards with specific levels of purity are used as specified by the analytical protocol. Specific GC column materials, glassware and sample handling equipment are also specified. The quality control procedures for equipment and supplies generally include the following items:

- operator checklists for required supplies,
- documentation and reporting of all deviations from specified instrument performance,
- procedures for testing for purity of reagents,
- tolerances for calibrated glassware where applicable,
- monitoring of refrigerated storage space,
- maintenance logbooks,
- service contracts on analytical instrumentation.

Quality control procedures during sample preparation include the preparation of reagent or solvent blanks. Additional quality control techniques implemented in sample preparation include:

- deionized water piped into all laboratories, monitored daily,
- purchasing high purity distilled-in-glass solvents in large quantities from a single lot,

- use of Ultrex acids in trace metal digestion,
- cleaning of organic glassware with chromic acid or firing in a kiln at 450°C,
- cleaning of trace metal glassware with nitric acid,
- use of organic-free water prepared at Radian by distillation over alkaline permanganate under nitrogen atomsphere in all-glass still,
- use of volatile-free water prepared by purging organic-free water with nitrogen,
- sample preparation performed by experienced technical personnel under the supervision of senior level analysts.

2.5 Quality Control for Standards and Calibration

The quality of all test results is greatly impacted by the calibration procedures used. Calibration procedures and standards should be specified for all equipment and supplies used in the test procedure. Traceability to common standards is essential for test procedures to be used in multiple laboratories. Quality control procedures for standards and calibrations include the following considerations:

- written, detailed calibration instructions,
- preparation procedures for secondary standards, when applicable,
- requirements for frequency of calibration,
- recordkeeping of all calibrations and standards used,

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- quality control charts for recording results from multiple calibrations,
- evaluation of internal standards, and
- tolerances for calibration requirements.

All calibration standards are prepared from NBS-traceable, EPA certified, or primary standard materials. Daily logs are maintained to monitor instrument response to a given standard.

Quality Control Test Samples

Routine quality control samples to be analyzed concurrently with client samples are a significant portion of the RAS laboratory quality control programs. The purpose of these checks is twofold: 1) to assure that samples being analyzed satisfy predetermined standards of accuracy, and 2) to measure and document achieved levels of accuracy and precision.

There are many different types of quality control samples which could be used for these purposes. The correct combination of these will depend on the complexity of the test method and the desired degree of accuracy. The following quality control parameters are general considerations for Radian's quality control for test methods.

Interferences

The analytical results of a test method might be affected by interferences from the glassware, solvents, reagents, or the sample matrix. Blank samples which are subjected to conditions similar to samples being analyzed are used to evaluate the purity of laboratory reagents. The frequency of blank analysis is method dependent. For example, a laboratory or field blank is analyzed after each GC/MS volatile organic analysis with high levels for any of the pollutants. Ten percent of the samples from a

given sample batch are spiked with a known standard. Spike recovery data are calculated to determine matrix interference.

Precision

The precision or repeatability of a test method is required for proper interpretation and weighting of the data. Replicate samples or standards are used to determine the precision on a regular basis. The precision of multiple analyses are compared against predetermined precision limits to determine their acceptability. The precision is usually reported as a standard deviation or repeatability statistic and often depends on the concentration of the parameters analyzed. Replicate analyses are defined as separate digestions or extractions of the same sample, when possible. The percentage difference or range between replicate analyses is also used to monitor precision.

Reproducibility

The reproducibility of a test method refers to the repeatability over a period of time. How well will analytical results repeated a month later agree with today's results? Reproducibility can be measured by the repeated analysis of samples from a previous time period or by analysis by more than one laboratory or laboratory technician.

Qualitative Specificity

In the analysis of complex sample matrices containing multiple components, the use of a single method can lead to misidentification of compounds. The misidentification can be detected by repeated analysis of standards containing the compounds of interest or by independent analysis by a more specific method. For example, mass spectral confirmation can be used to evaluate misidentification problems in the GC laboratory.

2.6 Documentation and Data Handling

Documentation of methods, procedures, and results is an essential aspect of a QA/QC program.

Adequate documentation is required for an instrument maintenance system. RAS laboratories use an individual logbook, which is kept at each instrument, to record all calibration and maintenance activities. This logbook gives a chronology of that instrument's installation, operation, calibrations, maintenance, malfunction, and repairs. An accompanying binder includes all pertinent manufacturing information, service manuals, and similar reference materials.

Directions for calibrations and maintenance, along with appropriate forms and checklists, are maintained in a manual accompanying the logbook. The directions specify the required frequency for calibrations and maintenance, the tolerances for calibrations, and the action to be taken when calibration requirements are not met.

In this system, there is a single source for reference purposes as well as record keeping. All the instrument logbooks are reviewed periodically by the quality assurance coordinator and laboratory manager. A record of these logbook checks is maintained by the QA coordinator.

Work sheets have been developed to insure consistent laboratory data entry for most parameters determined in the laboratories. These sheets are designed to organize the data in a clear and logical manner, and to simplify calculations. The work sheets are divided into various sections including a section for reporting calibration standards and blank values and a section for plotting calibration curves. These work sheets are usually a standard data entry form which the laboratory technician enters in his/her bound lab notebook. When automated calibration is not applicable, electronic calculators are available in the laboratories to generate calibration curves by the method of least squates. Thus errors in reading calibration curves and calculating data are minimized. After an analysis

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is completed and a data sheet filled out, the laboratory manager checks the data for completeness and approves the data sheet. After the data have been entered into the SAM system, an updated data sheet is issued to the laboratory manager. When the work is complete, a preliminary report is printed and distributed to the contributing laboratory managers for the final data check and approval. A final report is printed, certified by the laboratory manager, and forwarded to the client.

Proper documentation of quality assurance and quality control activities is an essential requirement. Documentation is needed to demonstrate that quality control activities were completed as scheduled and to communicate the results of the QC tests to laboratory managers and clients. Documentation of QA results is required to provide feedback for improvement of quality control programs.

Quality control documentation should be timely in order for feedback to occur. Daily reporting to laboratory managers is mandatory. Forms are designed to organize the QC data in a clear and logical manner, and to simplify calculations. Control charts are another excellent tool for summarizing quality control test results.

As part of Radian's QA audit program weekly reports summarizing audit results in the laboratories are prepared and distributed to QC coordinators.

3.0 Quality Assurance Audits

The quality assurance audit program of the RAS laboratories is conducted by the RAS QA Coordinator in conjunction with the corporate QA Director. The program consists of the following:

- QA standards are prepared using EPA certified standards, NBS standards, primary standard materials, and NBS-traceable compounds. All standards preparations are recorded in the QA Sample logbook (Figure 3-1).

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Standard No. QAS ______________

QA type ____________________________

Prep date ______________ Prepared by __________________ Verified by______________

Standard source ____

____

Sample matrix ____

Parameters

Preparation method Final vol______________

Figure 3-1. Standards preparation logbook

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QAS ______________

Prep method (con't)

Calculations

Sample Distribution

Date	SAM No.	Client	Remarks

Figure 3-1. (Cont.)

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- An inventory of stock standards is maintained within the limits of published stability data. This decreases the time required for daily standard preparation.

- Duplicate samples are requested from clients. These are blind to the laboratory and the client is not billed for the duplicate.

- Blind QA samples are submitted through the Sample Control Center to all laboratories. The parameters and concentration levels are selected by the RAS Quality Assurance Coordinator.

- Laboratory managers submit, via a "QA Alert Form" (Figure 3-2), a list of the types of QA samples needed the following week. This insures that the parameters with which there have been problems are included in the sample.

- Monthly reports are issued from the RAS QA Coordinator (Fig. 3-3). These are submitted to the corporate QA Director, laboratory managers and Director of RAS. Managers are notified immediately of major problems with the results of analysis of a QA sample.

- The results of the program are summarized on a quarterly basis for Radian's management.

In addition to the continuous audit program, provisions for third party review are made with each client's work. Radian Analytical Services welcomes onsite audits, performance samples, and independent evaluations.

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QA ALERT FORM

QA standard for the week of ____________

NPDES
- Form A water __
- Form B water __
  - metals __
- Form C water __
  - metals __
  - organics __

RCRA metals __ pesticide
anions __ OC __ OP __
herbicide __

EPA 601 __ 624 __
602 __ 625 __

B/N __ Acids __ A/N __

TOC __ TOX __

MS VOA __ GC VOA __

PCB __

Matrix requirements: ____________

Concentration requirements: ____________

Special Standards/Instructions	Individual Parameters

Date ____________ Mgr ____________

Figure 3-2. QA alert form

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ANALYTICAL SERVICES
MONTHLY QA REPORT

QA prep report for the month of ______________

Order No.	Lab	Parameter	Certified Value	Analyzed Value	% Recovery	Date Reported

Figure 3-3. Monthly QA Report

3.1 Data Review and Validation

All analysis results are entered into the SAM computer system. Following completion of the analyses, a preliminary report is printed and returned to the appropriate laboratory manager for review and validation. A final report is printed after the certification by the manager. This report is signed and approved by the laboratory manager before being forwarded to the client. The following diagram (Fig. 3-4) illustrates the data flow for a typical sample analysis.

Upon completion of the analysis and before the final data are issued, the results of the QA audit samples are compared to the certified values. These results are plotted on control charts. Separate control charts are maintained for each analysis. If results are outside the accepted control limits, the analytical results are held until the problem is resolved.

3.2 Control Charts

Quality control charts are maintained for both accuracy and precision. Both charts are structured as shown in Figure 3-5. The main portions of the chart are the center line and the two control limits. The center line is the 100% or total recovery/total agreement of analytical results. The upper and lower control limits are calculated from historical data.

Control charts for accuracy are constructed as follows:

Precent recovery of standards (P_{ST}):

$$P_{ST} = 100 \times \frac{\text{analyzed value}}{\text{certified value}}$$

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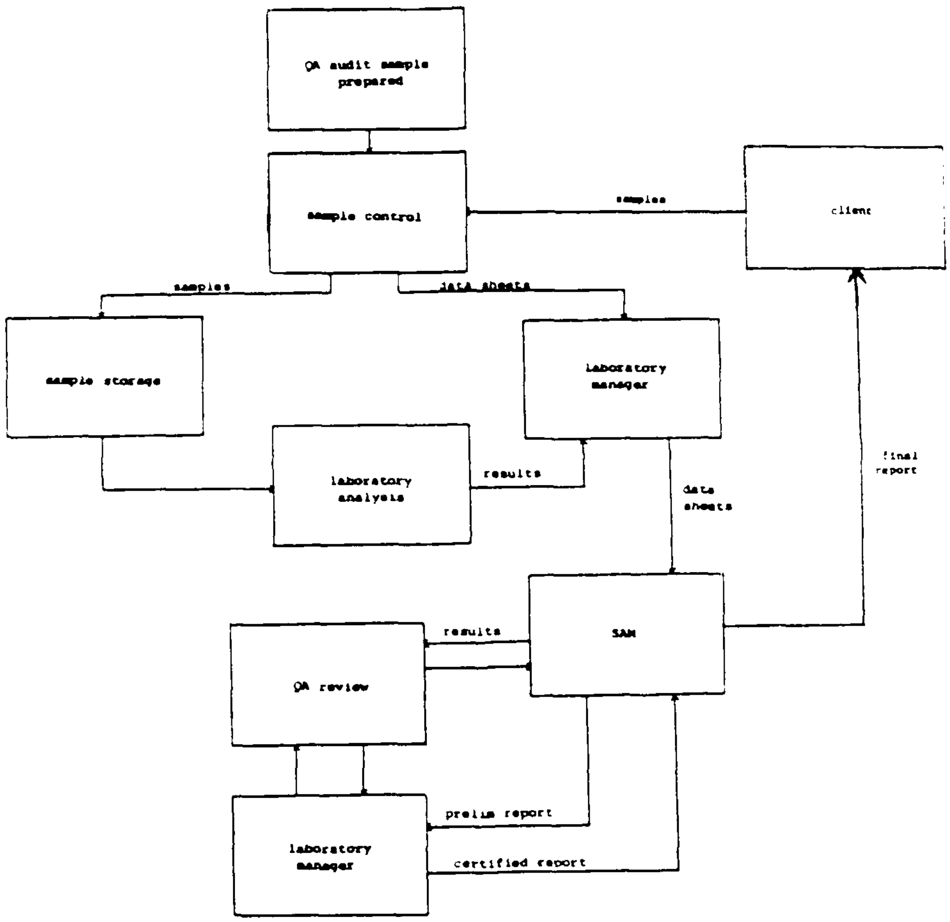

Figure 3-4. Data Flow

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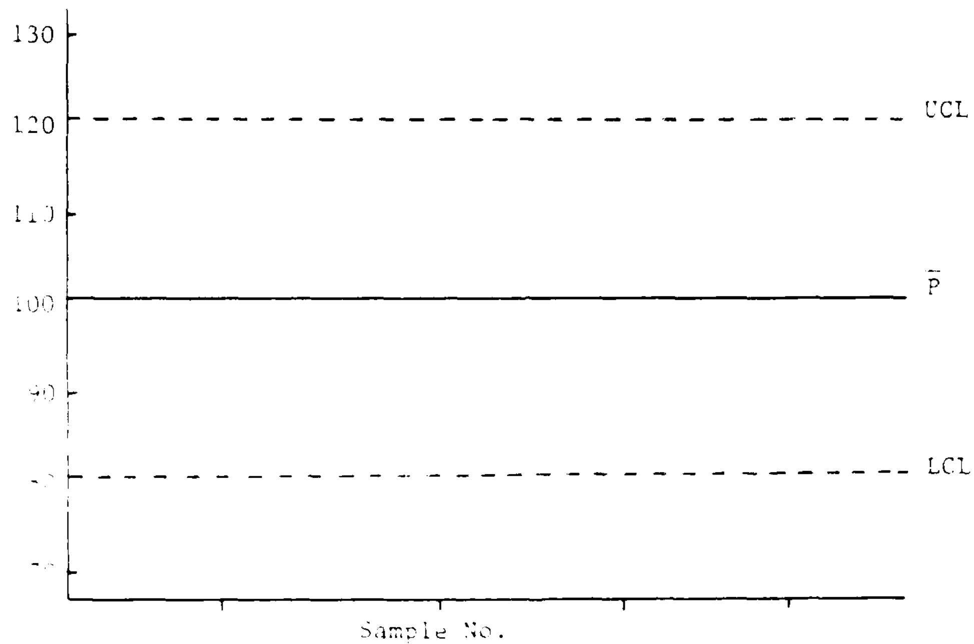

Figure 3-5. Control Chart

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Percent recovery of spikes in samples (P_{SP}):

$$P_{SP} = 100 \times \frac{\text{analyzed value - background value}}{\text{spike}}$$

From a set of analyses, the average percent recovery ($\bar{P}$):

$$\bar{P} = \frac{\sum_{i=1}^{n} P_i}{n}$$

The standard deviation for percent recovery (S_R):

$$S_R = \sqrt{\frac{\sum_{i=1}^{n} P_i^2 - \left(\sum_{i=1}^{n} P_i\right)^2 / n}{n-1}}$$

The upper and lower control limits are therefore

$$UCL = \bar{P} + 3S_R$$
$$LCL = \bar{P} - 3S_R$$

An analysis is out of control when either of the two conditions apply:

1) Any results outside the control limits
2) Seven successive results on the same side of the control line.

Control charts for precision are also constructed. Precision is a function of the concentration range of the analyte. The closer the result is to the analytical detection limit, the more imprecise the data become on a percentage scale. Figure 3-6 illustrates the relationship between detection limit and precision for a typical methodology. Because of this concentration dependence, precision control charts need to be developed for specific concentration ranges for each analyte. For duplicate samples A and B, the ratio of the values of A and B are plotted.

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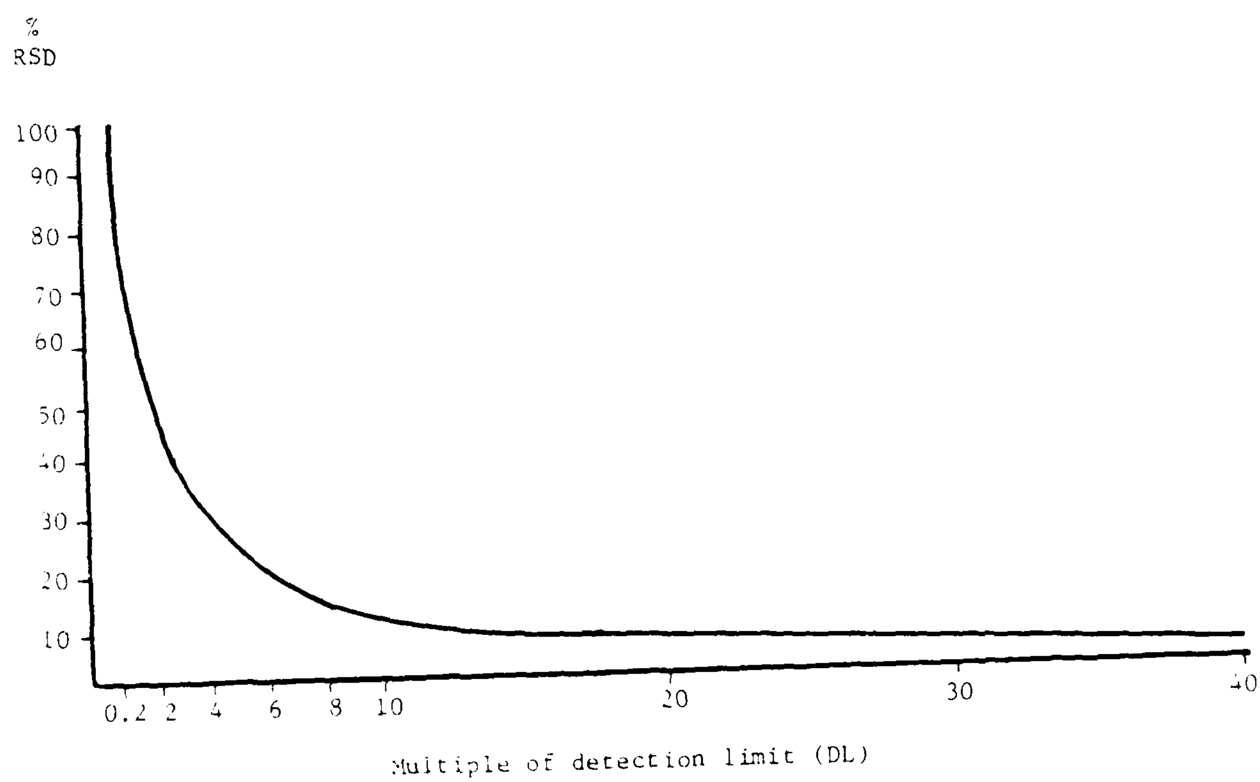

Figure 3-6. Relationship between Detection Limit and Precision

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3.3 Concurrent Review

Upon review of analytical results of QA audit samples, the QA Coordinator will schedule a meeting with the laboratory manager if there are any tests out of control or which are deviant from an expected precision/accuracy norm. The purpose of this meeting is to:

- review raw data and determine if there is an explanation for the deviance.
- outline analyses of quality control and/or quality assurance samples to further define the problem and its solution.
- establish a schedule for monitoring the analysis after a solution is implemented, to assure that the problem does not recur.

Involvement of the laboratory manager in the problem assessment and solution is essential to a mutual committment to a quality analytical laboratory.

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APPENDIX G

References

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APPENDIX H

Biographies of Key Personnel
(in alphabetical order)

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LAWRENCE N. FRENCH

EDUCATION:

M.A., Geological Sciences, University of Texas at Austin, 1979.

B.S., Geological Sciences, University of California at Riverside, 1975.

EXPERIENCE:

Senior Geologist, Radian Corporation, 1985-Present.

Staff Geologist, Radian Corporation, 1979-1984.

Geologist, Sargent & Lundy Engineers, Chicago, IL, 1978-1979.

REGISTRATION/CERTIFICATION:

Registered Geologist No. 3804, California
American Institute of Professional Geologists, CPGS No. 6307

FIELDS OF EXPERIENCE:

At Radian, Mr. French is involved in a variety of hydrogeologic and geologic studies. His roles in these studies range from collecting and analyzing hydrogeologic data, interpreting and reporting results of investigations, to directing interdisciplinary programs.

Mr. French is currently directing a Ground-Water Assessment program at a large West Coast oil refinery. The assessment, which is responsive to a state-ordered remedial investigation, involves a study of subsurface hydrocarbon lenses existing on the water table at the refinery and in neighboring communities. Nearly 200 wells and borings have been evaluated as part of this program, which is part of a much larger ongoing remedial investigation conducted by Radian.

A RCRA groundwater detection monitoring program was recently designed by Mr. French for a hazardous waste management area at a large petroleum refinery in Illinois. The groundwater program, a component of a Part B application, provided for sampling and analysis of groundwater at compliance monitoring points and specified monitoring parameters. In another RCRA Part B program, Mr. French was responsible for the ground-water monitoring data at a Gulf Coast chemical plant.

At Air Force Plant 4 and Carswell AFB, Texas, Mr. French is Project Director of investigations to determine the effect of waste-disposal sites on soil, surface water, and groundwater. The programs, part of the nationwide DOD Installation Restoration Program, involve installation of monitor wells, soil gas surveys, geophysical surveys, collection and analysis of environmental samples, and interpretation of data. Recommendations for appropriate

future actions will be based on the findings of this investigations. Mr. French is also directing a similar investigation for the Navy Assessment and Control of Installation Pollutants (NACIP) at the Marine Corp Development and Education Command, Quantico, Virginia.

He has also been responsible for field activities related to the USAF Installation Restoration Program at Tinker AFB, Oklahoma. At Tinker, electromagnetics surveys were performed at closed industrial waste impoundments and monitoring wells were installed near landfills. At England AFB, Louisiana, Mr. French developed a work plan for the field evaluation of waste disposal practices at the base.

Mr. French served as Task Leader for the field portion of an environmental audit of a major DOE-owned research facility near San Francisco. This project involved a detailed look at the regulatory compliance status of the facility, which generates, stores, transports, and disposes of a wide variety of hazardous materials and wastes. The audit, which included contacts with nearly 1,000 people and visits to dozens of buildings, uncovered a number of areas needing upgrading in order to achieve regulatory compliance.

Mr. French has also been involved in various aspects of ground-water investigations at several hazardous waste disposal sites. He recently served as Project Director for a study of PCB-contaminated soils at an industrial site in North Texas. The study involved sampling and analysis of near-surface soils to define the extent of PCB contamination. Remedial measures options were also identified. Mr. French also developed a ground-water monitoring plan in accordance with the Compliance Agreement between the state and the property owner. As Ground-Water Task Leader, he supervised the installation of monitoring wells at an abandoned petroleum products waste dump in Southern California. He later co-authored a technical report on the occurrence and character of ground water at the site. Mr. French also prepared technical designs and specifications for a permanent, post-remedial action ground-water monitoring network.

As part of a comprehensive hydrogeologic evaluation of a solvent refined coal pilot plant in Washington, Mr. French supervised the installation of water quality monitoring wells and conducted pumping tests for the evaluation of aquifer characteristics. He also supervised soil coring and sampling efforts at the site of process fluid spill. Mr. French also served as Project Director for a pre-closure evaluation of two hazardous waste impoundments at a wood treatment plant in Washington. The plant had discharged wastewater containing creosote and pentachlorophenol to the unlined impoundments, which are located on floodplain sands and gravels of the Columbia River. A second site was also examined in terms of disposal practices and the character and volume of wastes. Results of the preclosure survey were used for a definition of areas of concern requiring closure and for the selection of ground-water monitoring parameters based on the character and volume of wastes.

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Lawrence N. French

While employed by Sargent and Lundy Engineers, Mr. French was involved in detailed hydrologic and geologic studies for Preliminary and Final Safety Analysis Reports (PSAR and FSAR) for several nuclear power plants. The PSARs and FSARs involved detailed geologic mapping, inventory of water wells, analysis of subsurface flow, and reviews of regional geologic features. Mr. French also analyzed stratigraphic, structural, and hydrologic features at power plant sites in the Illinois Basin for a compressed air energy storage project. Mr. French directed an extensive hydrogeologic and geologic study of potential sites for a lignite-fired electric generation station in Walker County, Texas.

HONORARY AND PROFESSIONAL SOCIETIES:

Ground-Water Technology Division of the National Water Well Association

PUBLICATIONS/REPORTS:

Radian Corporation, "Installation Restoration Program Phase II - Field Evaluation, Stage 1, Carswell AFB, Texas," report to Air Force Occupational and Environmental Health Laboratory, May 1985.

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White, D.M. and L.N. French, "Evaluation, Screening, and Prioritization of Candidate Gulf Coast Lignite Resource Blocks," Radian Corporation, Austin, TX, April 1981.

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Lawrence N. French

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U.S. Bureau of Land Management, "Proposed Camp Swift Lignite Leasing (Draft and Final EIS)," Radian Corporation, Austin, TX, September 1980.

French, L.N., "Compilation of Environmental Information for a Proposed Olefins Complex, Brazoria County, Texas," Radian Corporation, Austin, TX, July 1981 (author of Ground-Water Hydrology and Topography and Geology chapters).

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GARY D. HENDERSON

EDUCATION:

M.S.(pending), Geology, Baylor University, Waco, TX, expected in December 1986.

B.S. with Distinction, Geology, Colorado State University, Ft. Collins, CO, 1980.

EXPERIENCE:

Geologist, Radian Corporation, Austin, TX, 1986-Present.

Graduate Teaching Assistant, Department of Geology, Baylor University, Waco, TX, 1984-1986.

Consulting Geologist, Shield Energy, Inc., Austin, TX, 1984.

Geologist, Wold Minerals Exploration Company, Austin, TX, 1983-1984.

Consulting Geologist, Rocky Mountain Energy Company, San Antonio, TX, 1982.

Geologist, Rocky Mountain Energy Company, San Antonio, TX, 1982.

Geologist, Wold Nuclear Company, Austin, TX, 1981-1982.

Temporary Geologist, Conquista Project (Conoco, Inc.), Falls City, TX, 1980-1981.

Summer Assistant, Mobil Oil Corporation, Energy Minerals Division, Denver, CO, 1979.

FIELDS OF EXPERIENCE:

Geologist, Radian Corporation; field supervision of test boring and monitor well installation for studies concerning soil and groundwater contamination. Soil and water sample collection. Report generation.

Graduate Teaching Assistant; taught undergraduate geology laboratories in mineralogy and igneous petrology.

Consultant to Shield Energy. Inc.; performed mudlogging and well site geology duties on 4,670' wildcat well in Taylor County, Texas. Evaluated prospects for hydrocarbon potential. Prepared geologic reports for drilling prospectus.

Geologist, Wold Minerals Exploration Company; conducted geologic and geophysical mapping in Precambrian metamorphic terrain of West Texas for talc deposits. Supervised the drilling of 191 drill holes (air hammer) totalling

27,608' for the purpose of exploring for the talc deposit. Calculated ore reserves and generated geologic reports. Supervised and participated in claim staking operations in Arizona and Nevada for uranium. Evaluated uranium deposits for possible acquisition.

Geologist, Rocky Mountain Energy Company, Wold Nuclear Company, and Conoco, Inc.; supervised the rotary drilling of at least 750 exploration and mine delineation drill holes totalling over 240,000' for uranium exploration and mining. Described sample cuttings, described 2,520' of core (109 core holes), and supervised the geophysical logging of boreholes. Calculated grade of mineralization from radioactivity logs, calculated ore reserves and prepared geologic reports. Budgeted individual projects.

Summer Assistant, Mobil Oil Corporation; conducted stratigraphic study of underground coal gasification pilot project in Powder River Basin of Wyoming. Electric log interpretation. Isopachous mapping of coal seams and inter-seam sandstones.

PROFESSIONAL SOCIETIES AND HONORS:

Junior Member of Society of Mining Engineers of AIME (SME-AIME)
Member of the Central Texas Mining Section of SME-AIME
Winner of Gerald V. Henderson Industrial Mineral Scholarship from Society of Mining Engineers of AIME for 1985.
Winner of Outstanding Student Paper Contest (Graduate Division) from SME-AIME, 1985.

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WALLACE J. HISE

EDUCATION:

B.S., Civil and Environmental Engineering, University of Wisconsin - Madison, 1984.

Graduate courses in Civil and Environmental Engineering, University of Wisconsin.

EXPERIENCE:

Environmental Engineer, Radian Corporation, Austin, TX.

Teaching Assistant, Department of Civil and Environmental Engineering, University of Wisconsin, Madison, WI, 1984-1985.

FIELDS OF EXPERIENCE:

As an environmental engineer at Radian, Mr. Hise works on the technical staff solving problems for private industry and government. His primary interests lie in the areas of solid and hazardous waste management, wastewater treatment, and water resources engineering.

Recently Mr. Hise prepared a Hazardous Waste Management Plan (HWMP) for a U.S. naval base in Texas. Along with other Radian staff, he developed a system of tracking wastes from the point of generation through ultimate disposal by designing waste handling and waste identification forms. The final document also included emergency response procedures, inspection schedules, and a training plan.

Mr. Hise co-authored a manual describing state-of-the-art technology and installation practices for underground petroleum storage systems. His tasks included an extensive literature search, vendor survey, and organizing and writing the final report.

Mr. Hise has assisted in preparing several RCRA Part B permit applications. His work included preparing sections of engineering reports, facilities management plans and trial burn plans, as well as helping to assemble the overall documents.

He prepared an exposure assessment for hazardous waste surface impoundments at a chemical manufacturing plant in Texas. This included defining several pathways for contaminant migration and determining the potential for human exposure through surface water, ground water, air, and soil. The task required interaction with regulatory and municipal agencies to gather information.

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Wallace J. Hise

At a waste oil contaminated site, Mr. Hise supervised the installation of ground water monitoring wells. He also assisted in the testing and installation of a carbon absorption unit used for groundwater treatment at the site, and preparation of a report recommending site remedial action efforts.

Mr. Hise has gained valuable experience on field procedures and safety through numerous projects requiring sampling of soil, air, water, and aquatic life for analysis of hazardous and organic constituents. These include: sampling and monitoring of the exhaust gas from a carbon absorption unit; implementing soil sampling schemes for the closure of a wastewater treatment plant lagoon and clean up of a pesticide-contaminate site; sampling of ground water wells; and participation in other soil and biological sampling plans.

PROFESSIONAL/HONORARY SOCIETIES:

Member of American Society of Civil Engineers
Tau Beta Pi
Chi Epsilon

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WENDY J. JOHNSON

EDUCATION:

M.S., Geology, University of Minnesota at Duluth, expected 1986.

B.S., Geology, University of Wisconsin, 1982.

EXPERIENCE:

Geologist, Radian Corporation, Austin, TX, 1986-Present.

Research Assistant, University of Minnesota at Duluth, 1983-1985.

Teaching Assistant, University of Minnesota at Duluth, 1983.

Laboratory Technician, University of Wisconsin, 1981-1982.

FIELDS OF EXPERIENCE:

As a geologist at Radian, Ms. Johnson has participated in the sampling of previously installed monitor wells in support of a Phase II Installation Restoration Program for the U.S. Air Force (Plant 4) in Fort Worth, Texas.

In a similar project at Kelly Air Force Base in San Antonio, Texas, Ms. Johnson assisted in supervising the installation of several ground-water monitoring wells.

For a refinery in southern California, Ms. Johnson assisted in overseeing the field activities associated with a large-scale ground-water investigation to determine the extent of a subsurface hydrocarbon plume.

The emphasis in Ms. Johnson's graduate level training was in sedimentary petrology. Her Master's thesis demanded extensive field work and thin section analysis in order to present a detailed description of a Precambrian quartzite in northwestern Wisconsin. While working toward her Master's degree in Geology, Ms. Johnson served as a research assistant to the Dean of the College of Science and Engineering at the University of Minnesota at Duluth. Her duties included the design and implementation of a series of experiments to determine the acid neutralizing capacities of major rock types, preparation of samples for X-ray diffraction and neutron activation analysis, the operation of an X-ray diffractometer, and the analysis of X-ray diffraction charts. Ms. Johnson also taught the laboratory portion of an introductory geology course at the University of Minnesota at Duluth.

At the University of Wisconsin Ms. Johnson was employed as a Laboratory Technician in the Geochemistry Laboratory of the Department of Geology and Geophysics. Her primary duty in this position was the operation of an ion chromatograph.

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Wendy J. Johnson

HONORARY AND PROFESSIONAL SOCIETIES:

Member of National Water Well Association
Member of American Association of Petroleum Geologists

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WILLIAM M. LITTLE

EDUCATION:

M.S., Civil Engineering, University of California, Berkeley, 1974.

M.S., Hydrology, University of Arizona, Tucson, 1968.

B.S., Hydrology, University of Arizona, Tucson, 1967.

EXPERIENCE:

Senior Staff Engineer and acting Head, Environmental Analysis Department, Radian Corporation, Austin, TX, 1986-Present.

Senior Engineer (1978-1985) and Group Leader (1982-1985), Radian Corporation.

Hydrologist, U.S. Army Environmental Hygiene Agency, 1973-1978.

Research and Technical Operations Officer, U.S. Army Engineer Nuclear Cratering Group, 1969-1971.

Graduate Student in Research, University of Arizona, Tucson, AZ, 1968.

CERTIFICATION:

AIPG Certified Professional Geological Scientist No. 6468.

FIELDS OF EXPERIENCE:

Mr. Little is a Senior Staff Engineer with a major technical specialty in ground-water pollution studies. He is also currently acting as head of the Environmental Analysis Department. He is the Radian Technical Coordinator for all USAF Occupational and Environmental Health Laboratory sponsored hazardous waste site investigations at multiple Air Force bases, nationwide. Mr. Little is the model development task leader for an EPA-sponsored study of the hydraulic performance of a RCRA-designed hazardous waste landfill. He is also providing hydrogeologic and ground-water modeling support for a power plant waste disposal site evaluation in Florida. He has also recently completed a hydrologic analysis of the water resource impacts of a proposed water supply well for a new coal mine in northeastern New Mexico.

Mr. Littl has recently served as Project Director for hydrogeologic investigations of multiple waste disposal sites on Tinker Air Force Base, Oklahoma and Kelly AFB, Texas. These investigations include monitoring well construction, ground-water sampling, and contaminant transport assessment. He was responsible for program design and execution, subcontractor selectio, and managing and editing the final report. He has also provided technical

consulting and expert witness services for a hazardous waste site cleanup case in Kansas City, Missouri.

Mr. Little has recently completed a hydrogeologic investigation of a Superfund site in western New York state. The project included monitoring well construction, definition of ground-water flow system, assessment of contaminant transport potential, and presentations to regulatory authorities. Mr. Little served as Project Director and principal investigator. He has also served as Project Director and field manager for a large, multidisciplinary characterization of an abandoned hazardous waste disposal site in southern California. The waste materials consist of acid petroleum refinery sludges. Major areas of investigation were: chemical characterization of wastes and geologic materials; quantification of sulfur dioxide and hydrocarbon emissions; and ground-water monitoring. Mr. Little was responsible for managing the field operations and supervising report preparation.

Mr. Little has served as assistant Project Director and field manager for an investigation of the ground-water quality impact of a spill of a coal-distillate liquid at the SRC pilot plant near Tacoma, Washington. The study involved detailed unsaturated zone coring and designing and constructing a series of ground-water monitoring wells. A Remedial Measures Plan was formulated and adopted to remove contaminated materials and to prevent the further spread of ground-water contamination. Following the evaluation of the spill event, Mr. Little directed an expanded program to evaluate the ground-water quality effects of overall plant operations. The possible sources of contamination were identified and characterized. Mr. Little then developed a ground-water monitoring program and supervised the installation of the monitoring network. He designed and conducted aquifer pump tests to define aquifer performance and interpreted the results.

Mr. Little has also conducted a program to evaluate the extent of ground-water contamination by refinery operations and wastes at an oil refinery near Duncan, Oklahoma. The assessment was based on site reconnaissance, interviews with refinery personnel and a study of existing hydrogeologic and process data.

Mr. Little has completed two environmental/regulatory fatal flaw studies for lignite mines and associated power plants in East Texas. He was both Project Director, responsible for overall management and preparation of the final report, and hydrology task leader, responsible for assembling data on hydrologic conditions and assessing probable impacts. He has also served as task leader for regulations review, impact analysis and permit application preparation for a commercial-scale coal gasification facility in Wyoming and ground-water hydrology task leader for environmental analysis of a major lignite mine and associated synfuels plant in east Texas.

In another program, Mr. Little directed an evaluation of surface-water and ground-water availability in the vicinity of the proposed Solvent Refined Coal-II (SRC-II) demonstration plant and commercial facilities near Morgantown, West Virginia.

William M. Little

For a private industrial client, Mr. Little reviewed and evaluated the environmental monitoring data from the vicinity of an in-situ coal gasification test in the Powder River Basin of Wyoming. The water quality impacts of the test burn were assessed, and a program of aquifer restoration and hydrologic testing recommended. Based on available hydrologic and geochemical data, a conceptual model of the test site was developed. He also developed a ground-water monitoring and contingency aquifer restoration program for a proposed future test. The program includes selection of well locations and parameters for monitoring and specification of restoration strategies.

Mr. Little has also participated in an assessment of the environmental behavior of fluidized bed combustion (FBC) waste for EPA, IERL. Mr. Little was responsible for the design, construction and operation of field cells for testing FBC waste disposal alternatives and for the development of a preliminary waste transport model. He has also been project director and hydrology task leader in the evaluation of the environmental suitability of an ash/-scrubber sludge disposal site. He was responsible for the overall management of the program, evaluated the laboratory and hydrogeologic data and predicted contaminant migration.

As a hydrologist with the Water Quality Engineering Division, U.S. Army Environmental Hygiene Agency, Mr. Little served as a consultant to the Office of the Surgeon General and to major commands and installations on hydrologic aspects of water supply and wastewater disposal. He prepared design criteria for programs of effluent and receiving water monitoring at Army manufacturing and research facilities, evaluated ground-water pollution potential of waste disposal practices, and reviewed draft NPDES discharge permits issued to Army installations. He performed preliminary technical feasibility studies of land treatment of wastewater, including field investigations and trial systems design. He conducted environmental impact statement data requirements review and prepared and reviewed portions of environmental impact statements. Mr. Little also managed the Army Medical Department's nationwide Drinking Water Surveillance Program.

With the Corps of Engineers, Mr. Little was assigned as a Research and Technical Operations Officer, U.S. Army Engineer Nuclear Cratering Group. There he conducted a general investigation of hydrologic transport of radionuclides from Plowshare application sites. This work included literature searches, computer simulation, experimental design and conceptual modeling of transport phenomena. He also participated in final preparation of a 1971 Corps of Engineers report on Wastewater Management in the San Francisco Bay Region.

While at the University of Arizona, Mr. Little was a member of the Operations Research Study Group on the Tucson Basin, gathering background hydrologic material, and conducting a literature and data file search. He directed and participated in preliminary adaptation of a two-dimensional, finite difference model of a large, heterogeneous ground-water basin.

RADIAN
CORPORATION

William M. Little

HONORARY AND PROFESSIONAL SOCIETIES:

American Geophysical Union
American Water Resources Association
National Water Well Association
Sigma Xi

PUBLICATIONS/REPORTS:

Numerous technical reports in the fields of water resources development, ground-water contaminant migration, occurrence of radionuclides in ground water, land treatment feasibility and receiving water monitoring, including:

Little, W.M., et al., "Installation Restoration Program, Phase II - Confirmation/Quantification, Stage 2, Tinker AFB, Oklahoma," Radian Corporation, Final Report to U.S. Air Force, October 1985.

Little, W.M., et al., "Installation Restoration Program, Phase II - Field Evaluation, Stage 1, Tinker AFB, Oklahoma," Radian Corporation, Final Report to U.S Air Force, September 1985.

Little, W.M., et al., "Installation Restoration Program, Phase II, Stage 1, Field Evaluation, Kelly AFB, Texas," Radian Corporation, Final Report to U.S. Air Force, July 1984.

Little, W.M., "Hydrogeologic Investigations, Facet Enterprises, Inc., Elmira, New York," Radian Corporation Final Report to Facet Enterprises, Inc., September 1983.

Little, W.M., et al., "McColl Site Investigation - Phase 1," Radian Corporation Report to the Participants Committee, November 1982.

Little, W.M., et al., "Environmental Considerations and Air Quality Modeling for the Freestone County Project," Radian Corporation Report to Tenneco Coal Company, March 1982.

Grimshaw, T.W., et al., "Assessment of Fluidized-Bed Combustion Solid Wastes for Land Disposal," Draft Final Report, Radian Corporation Report to EPA Industrial Environmental Research Laboratory, December 1982.

Little, W.M., et al., "Environmental Considerations and Air Quality Modeling for the Edgewood and Mustang Creek Prospects and Associated Energy Park," Radian Corporation Report to Tenneco Coal Company, November 1981.

Little, W.M., et al., "Ground-Water Impact of SRC Pilot Plant Activities Fort Lewis, Washington," Radian Corporation report to Gulf Mineral Resources Company, January 1981.

William M. Little

Little, W.M., et al., "Ground Water Modeling at an In-Situ Coal Gasification Test," Radian Corporation Report to confidential industrial client, September 1980.

Little, W.M. and H.J. Williamson, "Recommended Ground-Water Monitoring and Aquifer Restoration Programs, Future In-Situ Coal Gasification Test," Radian Corporation Report to confidential industrial client, September 1980.

Little, W.M. and W.C. Micheletti, "Recommended Aquifer Restoration and Hydrologic Testing Program for an In-Situ Coal Gasification Test," Radian Corporation Report to confidential industrial client, August 1980.

Grimshaw, T.W. and W.M. Little, "Remedial Measures Plan for a Spill of Solvent Refined Coal Liquid at the SRC Pilot Plant, Fort Lewis, Washington," Radian Corporation Report to Gulf Mineral Resources Company, August 1980.

Little, W.M., et al., "Hydrologic Evaluation of a Combined Ash/FGD Sludge Storage Site, Craig Station," Radian Corporation Report to Colorado Ute Electric Association, July 1980.

Little, W.M., T.J. Wolterink, and M.H. McCloskey, "Water Availability Appraisal for the Proposed Solvent Refined Coal-II Demonstration Plant, Monongalia County, West Virginia," Radian Corporation Report to U.S. Department of Energy, February 1980.

Little, W.M., "Water Quality Geohydrologic Consultation No. 24-0286-77," Twin Cities Army Ammunition Plant, New Brighton, MN, 21-23 July 1976, U.S. Army Environmental Hygiene Agency, 11 January 1977 (six additional geohydrologic consultations).

Little, W.M., Drinking Water Consultation Visit No. 24-1301-77, Joliet Army Ammunition Plant, Illinois, 2-4 August 1976, USAEHA, 9 February 1977 (four additional drinking water consultations).

Little, W.M., Water Quality Geohydrologic Consultation No. 24-058-75/76, Land Disposal Feasibility Study, Fort Polk, Louisiana, 2-29 April and 9-29 October 1975, USAEHA, 19 August 1976 (three additional land treatment evaluations).

Little, W.M., Water Quality Monitoring Consultation No. 24-048-74/75, Aberdeen Proving Ground, Maryland, 25-27 February 1974, USAEHA, 17 December 1974 (three additional monitoring consultations).

Little, W.M., Water Quality Engineering Special Study No. 24-017-74, Mixing in Receiving Waters, 7 September-24 October 1973, USAEHA, 3 January 1974.

Little, W.M., Analysis of Hydrologic Transport of Tritium, U.S. Army Engineer Nuclear Cratering Group Technical Memorandum 70-7, Lawrence Radiation Laboratory, Livermore, CA, April 1971.

RADIAN
CORPORATION

William M. Little

Little, W.M., An Engineering and Economic Feasibility Study for Diversion of Central Arizona Project Waters from Alternate Sites, M.S. Thesis, Department of Hydrology, University of Arizona, Tucson, AZ, 1968.

RADIAN
CORPORATION

ARTHUR H. MORRILL

EDUCATION:

B.S., Geology, California State University, Sacramento, CA, 1984.

A.A., Horticulture, American River Community College, Carmichael, CA 1980.

EXPERIENCE:

Geologist, Radian Corporation, Sacramento, CA, July 1985 - Present.

Geologist, McLaren Environmental Engineering, Rancho Cordova, CA, April 1985 - June 1985.

Geologist, Stang Drilling and Exploration, Rancho Cordova, CA, August 1984 - April 1985.

Geologist, California State Department of Transportation, Sacramento, CA, Summer 1983.

Geologist, Mitchem Exploration, Reno, NV, Summer 1982.

FIELDS OF EXPERIENCE:

At Radian, Mr. Morrill is currently serving as Task Leader for field activities involving monitor well installation for the Installation Restoration Program (IRP) at McClellan Air Force Base, California. This program is investigating ground water contamination in and around McClellan AFB. In this role, Mr. Morrill has coordinated Radian's field geologists and industrial hygienists, supervised waste disposal and drilling subcontractors, and interfaced with Air Force engineers, state and county regulatory personnel. In addition, he worked as a drill site geologist for air percussion and hollow-stem auger rigs and sampled the completed monitor wells. Mr. Morrill also provided technical input on project-related proposals, subcontracts, and health and safety plans. Mr. Morrill wrote the summary of field activities and geologic interpretation concerning the McClellan IRP for the Air Force Occupational Environmental Health Laboratory (OEHL) report.

From March 1985 to June 1985, Mr. Morrill was employed as a geologist for McLaren Environmental Engineering where he logged and supervised installation of exploration and monitor wells using mud rotary and air rotary drilling techniques. This work was conducted with the IRP investigating ground water contamination at McClellan AFB.

From August 1984 to March 1985, Mr. Morrill was employed as a geologist for Stang Drilling and Exploration. His responsibilities included logging and installing water production and ground water monitor wells using mud rotary, air rotary, and hollow-stem auger drilling techniques. He has also

Arthur H. Morrill

conducted pump tests. Mr. Morrill was drilling supervisor for the installation and development of 35 monitor wells at Castle AFB, California, and 34 monitor wells at Travis AFB, California. These tasks were part of programs to investigate contaminated ground water at these bases.

Mr. Morrill worked as a geologist for Cal Trans in the summer of 1982 and for Milchem Exploration in the summer of 1983. In both of these positions he participated in field work including drilling, mineral exploration, geochemical sampling and field mapping.

RADIAN
CORPORATION

NEIL ANTHONY ROBINSON

EDUCATION:

Bachelor of Science, Environmental Toxicology, University of California, Davis, June 1984.

Associate in Arts, Liberal Arts, Indian Valley Junior College, December 1981.

Health and Safety Training for Workers at Hazardous Waste Sites, University of California, Berkeley, September 1985.

EXPERIENCE:

Environmental Scientist, Radian Corporation, Sacramento, CA, 1985.

General Information Officer, Commerce Department, Sacramento, CA, July 1984 to October 1984.

Pollutants Researcher, California Air Resource Board, Research Division, Sacramento, CA, January 1984 to March 1984.

Outreach Coordinator, Alcoholism Council of Marin, CA, June 1979 to August 1979.

FIELDS OF EXPERIENCE:

Currently, Mr. Robinson is the task leader for a water well sampling program at an Air Force base in Northern California. Mr. Robinson was responsible for the design and testing of an air lift water pumping system, as well as a bailing system. These two systems were used to remove water from the well prior to sampling. Mr. Robinson organized and implemented sample preparation, preservation and shipment. He is also actively involved in analytical data reduction, interpretation, and final reporting.

Mr. Robinson has worked closely with subcontractors in the development of recently drilled wells. This process involves power bailing and pumping large volumes of water from the well prior to sample collection.

Mr. Robinson has also sampled groundwater in residential areas to determine the extent of potential contamination from nearby waste disposal areas.

He also conducted a quality assurance and quality control review of organic vapor analyser calibration data. This data related directly to hundreds of surveys conducted in residential homes at a site where subsurface organic chemical contamination had been discovered. The results of this review were used to update the data base and ensure accurate QA/QC procedures.

RADIAN
CORPORATION

Neil A. Robinson

Mr. Robinson has participated in a dioxin soil sampling project. This project covered three northwestern states as part of a nationwide EPA study on dioxin contamination of soils.

Mr. Robinson conducted an asbestos air sampling project on a number of retired Naval ships to determine potential employee exposures during maintenance activities. He was solely responsible for data interpretation and report writing.

As a soil sampling task leader, Mr. Robinson directed field sampling activities at an abandoned steel refinery to characterize the waste slag and determine the extent of contamination to the underlying soil. He also participated in data reduction, interpretation and final reporting.

At Radian, Mr. Robinson has been primarily involved in a large environmental assessment and mitigation program for a major petroleum refinery in Los Angeles, California. The refinery has had historical leakage of gasoline products and feedstocks which has resulted in contamination of the area's groundwater and soil.

Mr. Robinson has been involved in a number of tasks related to this program. He has used field equipment, such as the Century Systems Organic Vapor Analyzer (OVA), to detect hydrocarbon vapors in residential soils, indoor and outdoor air, and groundwater. He conducted downhole flux measurements during vapor well drilling operations. Flux measurements were taken using an OVA, a downhole flux chamber, and other field testing equipment. These measurements are used to determine the extent of vapor migration through the soil. Mr. Robinson was also responsible for maintenance sampling of over 500 vapor wells, involving well purging and grab sampling using evacuated canisters.

Mr. Robinson has also taken part in the residential monitoring program conducted in the area of the contamination. OVA's have been used to measure ambient indoor hydrocarbon levels and to identify point sources of vapor migration into homes. In addition, Mr. Robinson has used activated charcoal sampling tubes and MDA 808 sampling pumps to gather samples for laboratory analysis for hydrocarbons. This program have required Mr. Robinson to monitor local sewer lines for evidence of hydrocarbon vapors, and sample soil at various depths to determine the extent of soil contamination in various residential areas. Mr. Robinson has also assisted in maintaining ambient air monitoring and meteorological stations which Radian installed to study air quality in the contamination area.

Other tasks have included:

- o drafting a grid for a waste energy site in California;
- o technical writing and editing of environmental monitoring data;
- o survey of water wells and plotting of information onto grid maps;

- use of a geotechnical bladder pump to obtain water samples from water wells at a petroleum refinery; and

- library research and updating of federal law binders.

As a General Information Officer for the Commerce Department, Mr. Robinson co-authored an instruction manual for Californian Loan Guarantee corporations. He also researched and assembled reports for office and departmental meetings.

As a Pollutants Researcher for the California Air Resources Board, Mr. Robinson researched and reported the health effects and the environmental fate of benzene. He wrote a 13 page report on the fate and health effects of chromium VI in the environment, which was subsequently used by the research department.

As a Outreach Coordinator for the Alcoholism Council of Marin, Mr. Robinson created and wrote public service announcements (PSA's) aired on local radio stations.

AWARDS:

Herbert Kraft Scholarship, April 1982. Resolution of commendation - Marin County Board of Supervisors, January 1980.

PROFESSIONAL SOCIETIES:

Genetic and Environmental Toxicology Association (GETA) since 1984.
Sigma NU Honor Society - Indian Valley Colleges.

RADIAN
CORPORATION

JILL P. ROSSI

EDUCATION:

B.A. Geography, The University of Minnesota at Minneapolis, 1972.

EXPERIENCE:

Geographer, Cartographer, Policy and Environmental Analysis Division, Radian Corporation, Austin, TX, 1980-Present.

Drafting and Graphics Assistant, Dam Safety Unit, Texas Department of Water Resources, Austin, TX, 1979-1980.

Cartographer, Continental Map Inc., Austin, TX, 1978-1979.

Teaching Assistant, University College-Geology, University of Minnesota at Minneapolis, 1972.

FIELDS OF EXPERIENCE:

At Radian, Ms. Rossi is responsible for producing maps and coordinating graphics for the Environmental Analysis Division. She utilizes data from a variety of technical disciplines (geology, hydrology, noise and air monitoring, sociology, soils, and hydrogeology) to create maps which clearly and concisely illustrate the written text. Ms. Rossi has been responsible for work in the following projects:

- Develop base maps and coordinate graphics throughout an Environmental Impact Statement prepared for the U.S. Bureau of Land Management for a central Texas lignite mine;

- Develop color overlay method of mapping for site selection process of commercial waste disposal sites in Texas and southeastern Oklahoma;

- Develop a series of figures used as illustrations in a manual for the Environmental Protection Agency on Remedial Actions at Uncontrolled Hazardous Waste Sites:

- Draft maps and coordinate the graphics for an Environmental Impact Statement for a synfuels plant in Tennessee;

- Create base and thematic maps for Air Force Installation Restoration Programs (Phase I and Phase II) for the following locations: Kelly AFB, Texas; Hill AFB, Utah; Bergstrom AFB, Texas; Cannon AFB, New Mexico; England AFB, Louisiana; Tinker AFB, Oklahoma; and Reese AFB, Texas; Carswell AFB, Texas; Sheppard AFB, Texas;

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Jill P. Rossi

- Map limestone deposits, lime plants, and limestone quarries in the United States by county in a series of regional maps for the Electric Power Research Institute;

- Map compliance/non-compliance with air pollution standards for all counties in the United States in a series of EPA regional maps;

- Map concentrations of selected air pollutants in the El Paso, Texas, area for a Texas Air Control Board study in a series of quarterly and annual reports;

- Prepare aerial photography history of a wood preserving plant for a commercial client which included extensive research of available aerial photography and interpretation of those photos to determine historical features of interest;

- Prepare complex permitting schedules for proposed mines, energy facilities, and hazardous waste handling facilities;

- Preparation of base and thematic maps for various feasibility studies, fatal flaw analyses, Environmental Information Documents, and Environmental Impact Statements;

- Identify, field verify, and map oil and gas development features within the Big Thicket National Preserve for the National Park Service; and

- Research of available map resources, aerial photography, remote sensing products, and mapping technologies as required by individual client needs.

While with the Texas Department of Water Resources, Ms. Rossi worked in the graphics section of the Dam Safety Unit, a federal grant program. She prepared maps and exhibits, and laid out phototypset text into camera-ready form according to standards, developed with her assistance, for the technical reports written by the engineering section.

During her employment with Continental Map Incorporated, Ms. Rossi was involved in all phases of four color map production. These included source information procurement and classification, imaging of base maps, scribing plates, cutting specialties, sizing and adhering type, designing customer copy panels, indexing streets and points of interest, photo-lab contact reproducing of base plates, and the final compositing of the four negative plates to be sent to the printer. These maps included large metroplex areas, counties, enlarged downtown sections, and simplified principle city thoroughfares.

Jill P. Rossi

While employed by the University of Minnesota as a Geology Teaching Assistant, Ms. Rossi taught geology laboratory sessions, prepared geology lab work materials, tutored students, and assisted the professors by preparing classroom presentations and grading and proctoring exams.

RADIAN
CORPORATION

ANN E. ST. CLAIR

EDUCATION:

M.A., Geological Sciences, The University of Texas at Austin, 1979.

B.A., Geology, Trinity University, 1973.

EXPERIENCE:

Department Head, Radian Corporation, Austin, TX, 1982-Present.

Senior Geologist, Radian Corporation, 1980-1985.

Group Leader, Radian Corporation, 1979-1982.

Staff Geologist, Radian Corporation, 1978-1980.

Research Scientist Associate, The University of Texas at Austin, Bureau of Economic Geology, 1975-1978.

Research Scientist Assistant, The University of Texas at Austin, Bureau of Economic Geology, 1973-1975.

REGISTRATION/CERTIFICATION:

American Institute of Professional Geologists, Certified Professional Geological Scientist No. 4741.

FIELDS OF EXPERIENCE:

At Radian, Ms. St. Clair has had extensive experience in studies relating to ground-water geology, waste disposal, and environmental impacts. Her work has included acquisition of data on ground water, assessment of water quality impacts, and compilation and interpretation of geologic data including geophysical and core logs, and evaluation of impacts of waste disposal and other activities. In hazardous waste studies her work has also involved participation in hazardous waste permitting projects, evaluation of remedial action alternatives and interface with engineers, chemists and other specialists regarding various aspects of hazardous waste investigations including engineering design and cost of remedial action, control of emissions and odors, and waste characteristics. As Department Head at Radian Ms. St. Clair supervises the work of geologists, hydrologists, civil and environmental engineers and atmospheric scientists and has management and technical review responsibility for programs in these technical areas.

Ms. St. Clair is currently Project Director for investigations being performed at McClellan AFB, California. The program is being conducted as part of the Air Force Installation Restoration Program to assess and mitigate impacts from

past waste disposal activities. The McClellan project includes installation and sampling of monitoring wells on and around the base, development of a computerized data base, aquifer testing, ground-water modeling, assessment of the extent of contamination, and evaluation of remedial action alternatives.

In 1984, Ms. St. Clair served as Task Leader for preparation of a RCRA Part B permit application for a large Gulf Coast petroleum refinery. In this role she is responsible for review and coordination regarding acquisition of ground-water and geology data and incorporation of this information into the permit application.

Ms. St. Clair was Project Director for an investigation to determine site conditions and develop a plan for remedial action at a site formerly occupied by an aerial pesticide spraying operation in Arizona. Radian determined the lateral and vertical extent of soil contamination by collection and analysis of nearly 100 soil cores. Alternative were evaluated for on-site treatment or recycling of the pesticide-bearing soils, and a plan was prepared for site mitigation. Construction of an on-site treatment bed was recently completed. Radian will monitor the progress of the treatment by periodic sampling and recommend any necessary changes.

Ms. St. Clair was Project Director for the second phase of a continuing study at the McColl hazardous waste site in the Los Angeles area. In this phase, data collected in Radian's Phase 1 field investigation of the site were evaluated and used in the selection and design of the remedial action plan for the site. The site, which is located adjacent to a residential and recreational area, contains various hydrocarbon wastes, principally acidic refinery sludges and drilling muds. Control of volatile emissions, odors, and the potential for contamination of surface water and ground water were addressed in the remedial action design. The design must meet strict criteria regarding exposure to contaminants both during remedial action implementation and over the long term.

Ms. St. Clair has had major responsibility for studies performed at several uncontrolled hazardous waste sites, including sites identified as priority sites for remedial action under Superfund. She was Project Director for the first phase of a study to evaluate ground-water conditions at a Superfund site in up-state New York which was used for disposal of wastes from a metal plating operation. The study included installation of monitor wells and test borings and collection of soil and ground-water samples in order to define the presence or extent of subsurface contamination. Based on the results of the field investigation, recommendations for further study or remedial action were developed. During the course of this program, Ms. St. Clair has been involved in initial site evaluation and data collection, development of a site field program, and interface with state and federal regulatory agencies.

Ms. St. Clair has had overall technical responsibility for a variety of activities for the EPA Solid and Hazardous Waste Research Division. These studies, generally involving technical support of Superfund activities, have included a field geophysical survey, treatability studies, column absorption/desorption

studies, hydrogeologic evaluations, review of feasibility studies, and evaluation of remedial action technologies for approximately ten Superfund sites. Ms. St. Clair's role included project management, technical supervision and review, and agency coordination.

For the Lipari Landfill Superfund site near Pitman, New Jersey, Ms. St. Clair was responsible for coordinating a variety of technical activities as support to EPA Region II. The site contains a variety of industrial wastes, of which several volatile organic chemicals known to be extremely hazardous are of primary concern. Leachate seeps enter surface streams adjacent to the site and have resulted in a ban on fishing and boating in a lake 1000 feet downstream. Ms. St. Clair had overall responsibility for coordinating the following activities at this site--cost-effectiveness evaluation of 32 remedial action alternatives, preparation of an Environmental Information Document assessing the environmental impacts of remedial action alternatives, definition of baseline conditions and design of a long-term monitoring program on the lake, and a treatability study of the landfill leachate. For all these activities Ms. St. Clair was the principal interface with EPA and had primary technical review and management responsibility.

In a study for the EPA Municipal Environmental Research Laboratory, Ms. St. Clair supervised development of a methodology for conducting evaluations of cost-effectiveness of remedial actions at uncontrolled hazardous waste sites. Under the Comprehensive Environmental Response, Compensation and Liability Act (Superfund), remedial actions conducted at Superfund sites must be demonstrated to be cost-effective. The study involved review of technical and cost data on remedial technologies, evaluation of methodologies for cost-effectiveness and related types of analyis, assessment of impacts of time and discount rates on the evaluation, and development of the analytical framework and guidance manual to be used by decision makers in selecting remedial measures.

Ms. St. Clair has participated in Radian's activities related to collection of insurance underwriting information for Environmental Impairment Liability (EIL) Insurance. She worked closely with Radian's parent company, Hartford Steam Boiler Inspection and Insurance Company (HSB) in developing procedures for collection of technical and engineering underwriting information and functions in a Quality Assurance role by reviewing results of all Radian investigations of this type. In 1981 Ms. St. Clair was Project Director for a risk assessment of three power plants in the Boston area. The study involved brief site visits and review of corporate and regulatory agency files in order to assess the potential for gradual environmental impairment as a result of plant activities. The study included assessment of ground-water conditions, waste management practices, hazardousness of materials used on-site, population-at-risk, and corporate approach to environmental matters. A report was prepared containing information for use in underwriting Environmental Impairment (EIL) Insurance.

During 1981, Ms. St. Clair was Project Director for a large program to develop a waste management strategy for the Wyoming Coal Gasification Project. The program involved chemical and physical analysis and regulatory classification

of power plant and gasification wastes and organic by-products. Based on the results of the testing, recommendations were made for treatment and disposal of wastes to meet applicable regulatory requirements. In addition, the study included column leaching studies to assess impacts of mine disposal of plant wastes, evaluation of ground water impact of disposal facilities at the plant site, and preparation of a state industrial siting permit application and RCRA permit application. Because the gasification project was cancelled, these permits were never submitted.

In 1980-1981, Ms. St. Clair was Project Director for a program to evaluate waste disposal practices and ground-water conditions at a large petroleum refinery in Kenai, Alaska. The study focused on development of a long-term waste management strategy for disposal of refinery wastes, principally API separator bottoms and crude tank bottoms, which have been designated as hazardous wastes under RCRA. Initially Ms. St. Clair supervised design, installation and sampling of ground-water monitoring wells in the vicinity of existing disposal sites in order to assess the water-quality impacts of past disposal practices. Samples of all refinery waste streams and wastes from existing pits were characterized for the purpose of developing a plan for closure of existing pits and an ultimate waste management plan. Options were evaluated with respect to technical feasibility (particularly in light of climatic factors), environmental acceptability, regulatory compliance, and economics. Quarterly groundwater monitoring, on compliance with RCRA, is continuing at the facility.

In 1979, Ms. St. Clair was Project Director for an investigation of soil/ground-water contamination and remedial action at a pesticide formulation facility in north Texas. The study was aimed at evaluating possible contamination from underground waste storage tanks suspected of leaking. Ms. St. Clair initially conducted sampling of soils in the vicinity of the tanks to determine if leakage had occurred. She also designed and supervised installation of a network of ground-water monitoring wells in order to evaluate ground-water flow at the site and to assess water-quality impacts of the suspected leakage. During drilling, core samples were taken in both the unsaturated and saturated zone for chemical analysis. Ms. St. Clair performed slug tests on the wells to provide data on aquifer properties. She also supervised infiltration tests in order to evaluate the surface infiltration conditions and to qualitatively assess the potential for leachate generation. Based upon the results of this study, recommendations were made for further studies and possible remedial actions.

In a study to determine impacts of a product spill at a Solvent Refined Coal-II demonstration plant in Fort Lewis, Washington, Ms. St. Clair was responsible for portions of the ground-water evaluation, including installation of monitoring wells, measurements of water levels, and interpretation of hydrologic and chemical data. She was also involved in interfacing with state regulatory agencies.

Ms. St. Clair was Project Director of a study for EPA Region III, evaluating the suitability of land around the Cheswick Power Station near Pittsburgh,

Pennsylvania, for disposal of coal ash and scrubber sludge. The study was conducted as technical support for enforcement actions brought by EPA Region III concerning alleged violations of air emissions regulations from the coal-fired power plant. In the event that installation of SO_2 scrubbers was to be required by EPA, this study was undertaken to document the availability of land for disposal of wastes from the scrubbers. During the study, Ms. St. Clair supervised a multidisciplinary team evaluating the hydrogeology, transporta- tion, land use, ecology, and economic factors affecting the acceptability of sites in the vicinity of the plant for disposal of wastes.

In a study for EPA Region VII, Ms. St. Clair supervised several programs concerned with suitability of soils for septic tanks and nitrate contamination of ground water in Missouri. Ms. St. Clair supervised technical efforts on three programs. One program involved detailed soils mapping and field examination of septic tank failures in Greene County, Missouri, and in order to develop a septic-tank suitability map. Another study focused on determination of any relationships between water well construction practices and occurrence of ground water contamination in Howell County, Missouri. It involved a field survey for sampling of ground water and for obtaining information on well construction. A third program was conducted to develop a regional map of nitrate concentrations in ground water in the four-state area of EPA Region VII. In addition to development of technical reports for each of these studies, reports were prepared for lay readers.

Ms. St. Clair was Project Director for a feasibility and site selection study for an in-situ gasification project utilizing Texas lignite. The study focused on evaluation of environmental factors that might affect project feasibility. Ms. St. Clair was involved in overall project coordination as well as studies related to environmental and hydrologic conditions at several candidate sites.

As a research associate at the Bureau of Economic Geology, Ms. St. Clair was involved in numerous studies requiring collection and interpretation of geologic data, sampling and chemical analysis of ground water, and evaluation of environmental and engineering impacts of man's activities. She was responsible for the preparation of maps, technical reports, and presentations, as a part of these programs.

PROFESSIONAL/TECHNICAL SOCIETIES:

American Institute of Professional Geological Scientists
Certified Professional Geological Scientist 4741
National Water Well Association
Ground Water Technology Division
Geological Society of America
[illegible] Geological Society

[illegible]ATIONS:

RADIAN
CORPORATION

Ann E. St. Clair

Radian Corporation, "Cost-Effectiveness Evaluation of Remedial Action Alternatives for the McColl Site, Fullerton, California," Final Report, June 1983.

Radian Corporation, "Environmental Assessment of the Remedial Action Alternatives for the McColl Site, Fullerton, California," Final Report, June 1983.

Radian Corporation, "Evaluating Cost-Effectiveness of Remedial Action at Uncontrolled Hazardous Waste Sites," Draft Methodology Manual, January 1983.

St. Clair, A.E., M.H. McCloskey, and J.S. Sherman, "Development of a Framework for Evaluating Cost-Effectiveness of Remedial Actions at Uncontrolled Hazardous Waste Sites," Proceedings, Third National Conference on Management at Uncontrolled Hazardous Waste Sites, Washington, DC, December 1982.

Radian Corporation, "Draft Environmental Information Document for Remedial Actions at the Lipari Landfill, Pitman, New Jersey," July 1982.

Radian Corporation, "Cost-Effectiveness Assessment of Remedial Action Alternatives, Lipari Landfill," Revised Draft Report, June 1982.

St. Clair, A.E., et al., "Environmental Compliance Review and Risk Assessment for Selected New England Electric System Power Stations," Final Report, December 1981.

Radian Corporation, "Preliminary Conceptual Plan for Solid Waste Management at the Wyoming Coal Gasification Project," submitted to WyCoalGas, Inc., February 1981.

Radian Corporation, "Results of Waste Analyses and Preliminary Recommendation of a Waste Management Strategy at Tesoro Alaska's Kenai Refinery," December 1980.

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St. Clair, A.E., et al., "California Heavy Oil Production," Radian Corporation report to the California Energy Commission, November 1980.

George, F.M., et al., "Assessment of Gulf Coast Lignite Marketability," Final Report, August 1980.

St. Clair. A.E., et al., "The Availability of Western Coal for California Use," Final Report to the California Energy Commission, June 1980.

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Ann E. St. Clair

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Grimshaw, T.W., J.L. Machin, J.R. Mase, A.E. St. Clair, and F.H. Sheffield, "Hydrology Related Regulatory Risks for Lignite Mining at a Prospect in Eastern Texas and Western Louisiana," July 1979.

Garner, L.E., A.E. St. Clair, and T.J. Evans, "Mineral Resources of Texas (map)," Bureau of Economic Geology, University of Texas, Austin, 1979.

St. Clair, A.E., "Mineral Lands in the City of Dallas: Bureau of Economic Geology," University of Texas, Austin, Geological Circular 78-1, 1978.

St. Clair, A.E., T.J. Evans, and L.E. Garner, "Energy Resources of Texas (map)," Bureau of Economic Geology, University of Texas Austin, scale 1:1,000,000, 1976.

St. Clair, A.E., C.V. Proctor, W.L. Fisher, C.W. Kreitler, and J.H. McGowen, "Land and Water Resources, Houston-Galveston Area Council," Bureau of Economic Geology, University of Texas, Austin, Land Resources Laboratory Map Series, 25 p., 4 maps, scale 1:125,000, 1975.

RADIAN
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FRED L. SHORE

EDUCATION:

Research Fellow, National Institutes of Health Training Program, University of Hawaii, 1978-1979.

Ph.D., Organic Chemistry, Arizona State University, Tempe, AZ, 1971.

B.S., Chemistry, California State University, Fresno, CA, 1964.

EXPERIENCE:

Section Head, Analytical Chemistry Department, Radian Corporation, Austin, TX, 1985-Present.

Senior Scientist, Principal Scientist, Scientific Supervisor and Manager, Organic Analytical Department, Lockheed Engineering and Management Services Company, Inc., Las Vegas, NV, 1982-1985.

Professor of Chemistry, Jackson State University, Jackson, MS, 1970-1982.

FIELDS OF EXPERIENCE:

As a Section Head in the Analytical Chemistry Department, Dr. Shore manages the following groups: Sample Preparation, Chromatography, Gas Chromatography/Mass Spectrometry, Barrier Evaluation Technology, Repository Services, and Inorganic and Radiochemistry.

Dr. Shore is currently serving as Project Director on a project concerning GC/MS analysis of PCBs generated by a midwestern power plant, a project for analysis of Appendix VIII compounds in water from a RCRA waste site using GC and GC/MS techniques, and a project involving selected ion monitoring for GC/MS analysis of polychlorinated dioxins and dibenzofurans from transformer explosions.

With Lockheed, Dr. Shore directed projects on method development for SW 846 EPA Manual of Analytical Methods. Method 8280 for analysis of dioxins and dibenzofurans by GC/MS was refined and validated for soils, still bottoms, sludge and water samples. Method 8150 for analysis of chlorinated herbicides was also validated for methyl and pentafluorobenzyl derivatization and GC/EC analysis with GC/MS confirmation.

Dr. Shore supervised a project to compare GC/MS quantitation techniques for PCB congeners. It was verified that multiple internal standards and single ion monitoring improved analysis by the Grob injection-capillary chromatography-EI analysis mode.

Dr. Shore also supervised preparation and analysis of quality assurance materials used by the EPA to evaluate laboratory methods and performance.

Fred L. Shore

Pesticide and toxic organic compounds were spiked (or in vivo incorporated) into biological matrices (adipose, blood plasma and urine), clay and water and analyzed using methods provided by the EPA or developed in house. An important developed method was GC/EC for analysis of ethylene dibromide (EDB) in water. This method was also used to analyze well water samples for EDB for EPA Region 9.

Dr. Shore supervised the analysis of standards for the EPA Repository of Pesticides and Industrial Chemicals. This involved using differential scanning calorimetry, GC/MS, GC/FID and HPLC for purity assay and identity confirmation.

Dr. Shore's department in Las Vegas prepared and analyzed samples for the EPA's Contract Laboratory Program. This work was required for quality assurance of the program. The organic analyses of environmental samples for EPA Region 9 was also done by Dr. Shore's department.

As an NIH research fellow at the University of Hawaii (1978-1979), Dr. Shore used membrance solubilization and affinity labeling membrance structure studies. This involved synthesis of ^{32}P and ^{3}H analogs, sonication of membrance with detergent, flash photolysis, ultracentrifugation, electrophoresis, and scintillation counting.

At Jackson State University, Dr. Shore directed a multiyear study testing the ability of the water hyacinth to remove pesticides from water. Water hyacinth plant material with in vivo incorporated As, Cd, Hg and Pb was prepared by a feeding program with the water monitored by atomic absorption analysis and replenished with the toxic metals as required. The plant material was prepared and analyzed and is presently used by the EPA as a reference material.

As a summer faculty fellow at Iowa State University (1973), Dr. Shore directed the sampling and analysis of the well water in Ames, Iowa. This involved use of XAD-2 resin to remove and concentrate the organic compounds from water that had been contaminated by a waste dump from an old coal gasification plant. The samples were analyzed using GC/FID.

The summer of 1972, Dr. Shore was a National Urban League Summer Fellow at Colgate-Palmolive Research Center in New Jersey. Dr. Shore studied the reactions of acyl perborate activators in water using uv and titrimetry techniques.

JOURNAL ARTICLES:

Gurka, D.F., F.L. Shore, and S.T. Pan, "Pentafluorobenzylation Derivatization for the Analysis of Chlorinated Herbicide Acids," J. Assoc. Off. Anal. Chem., submitted for publication, 1985.

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Marsden, P.J., E.N. Amick, F.L. Shore, L.R. Williams, V.R. Bohman, and C.R. Blincoe, "Analysis of Biologically Incorporated Chlorophenols in Bovine Urine and Adipose as Part of the Preparation of Interlaboratory Performance Evaluation Samples," J. Agric. Food Che., submitted for publication, 1985.

Shore, F.L., J.D. Martin, and L.R. Williams, "Mass Spectrometric Quantitation of Polychlorinated Biphenyl Congeners Using Multiple Carbon-13 Internal Standards," Biomedical Mass Spectrometry, 13, 15-19, 1986.

Chigbo, F.E., R.W. Smith, and F.L. Shore, "Uptake of Arsenic Cadmium, Lead and Mercury from Polluted Waters by the Water Hyacinth Eichornia crassipes," Environmental Pollution (Series A), 27, 31-36, 1982.

Chigbo, F.E., M. Clark, L. Thompson, and F.L. Shore, "Simultaneous Absorption of Cadmium, Lead, Arsenic, and Mercury by Water Hyacinths," Journal of the Mississippi Academy of Science, 24, 13-31, 1979.

Smith, R.W., W. VanZandt, and F.L. Shore, "Water Hyacinths for Removal of Toxaphene from Water," Journal of the Mississippi Academy of Science, 23, 17-22, 1978.

Shore, F.L. and G.U. Yuen, "The Absolute Configuration of Methyl 3-0-Acetyl-2,3-Dihydroxy-2-Methylpropanoate by Nuclear Magnetic Resonance and Chemical Determination," J. Org. Chem., 37, 3703-3707, 1972.

LIMITED DISTRIBUTION DOCUMENTS:

Final Report, Analysis of Chlorinated Herbicide Acids using Pentafluorobenzylation Derivatization, (with S.T. Pan), September 1985.

Single-Laboratory Evaluation of the RCRA Method for Analysis of Dioxin in Hazardous Waste (with T.L. Vonnahme, C.M. Hedin, J.R. Donnelly, and W.J. Niederhut), May 1985.

Single Laboratory Validation of EPA Method 8150 for Analysis of Chlorinated Herbicides in Hazardous Waste, (with E.N. Amick and S.T. Pan), April 1985.

Final Report, Technical Support for the Pesticide Quality Assurance Program, (with E.N. Amick, R.L. Johnson, S.T. Pan, A.R. Bujold, P.R. Sheeley, and J.M. Ballard), January 1985.

Final Report, Evaluation of GC Method for Chlorinated Herbicides (Method 8150), (with E.N. Amick, S.T. Pan, P.J. Marsden and A.R. Bujold), January 1985.

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Preliminary Ruggedness Report, Evaluation of GC Method for Chlorinated Herbicides (Method 8150), (with S.T. Pan and E.N. Amick), September 1984.

Preliminary Test Report, Evaluation of GC Method for Chlorinated Herbicides (Method 8150), June 1984.

Gurka, D.F., F.L. Shore, E.N. Amick, and S.T. Pan, "Single-Laboratory Validation of a Method to Determine Herbicide Esters in Solid Wastes," ACS/SAS Pacific Conference on Chemistry and Spectroscopy, 1985.

Gurka, D.F., F.L. Shore, E.N. Amick, and S.T. Pan, "Single-Laboratory Validation of a Method to Determine Free Acid Herbicides in Hazardous Wastes," American Chemical Society National Meeting, 1985.

Shore, F.L., "Futures through Chemistry: Charting a Course," Third Annual Awards Banquet, American Chemical Society Boulder Dam Section, 1985.

Shore, F.L., G.W. Sovocool, E.J. Kantor, E.N. Amick, and A.R. Bujold, "Preparation and Analysis of Pesticide Adipose and Blood Laboratory Intercomparison Samples," American Chemical Society National Meeting, 1985.

Johnson, R.L., G.W. Sovocool, E.J. Kantor, E.N. Amick, A.R. Bujold, and F.L. Shore, "Differential Scanning Calorimetry for Purity Measurement of Pesticides/Organics of the EPA Reference Standards Repository," American Chemical Society National Meeting, 1985.

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Shore, F.L., E.N. Amick, J.D. Martin, and G.W. Sovocool, "Verification of Identity and Purity of Standards of the EPA Pesticide and Industrial Chemical Repository," American Chemical Society National Meeting, 1983.

Agaskar, P., J. Kilgore, and F.L. Shore, "DDT Metabolism by the Microsomal Fraction of the Water Hyacinth Leaf," Mississippi Midwinter Chemical Symposium, Mississippi State University, 1981.

Shore, F.L., N. Abel-Rahim, and D.O. O'Keefe, "Water Hyacinth Metabolism of Mirex," Annual Meeting of the Society of Environmental Toxicology and Chemistry, 80-81, 1980.

Shore, F.L. and R.J. Guillory, "Aryl Azido B-Alanine as a Photoaffinity Probe of Membrane Protein Activity," Journal of the MIssissippi Academy of Science, Supplement 24, 1980.

Manyfield, B. and F.L. Shore, "XAD Resin Adsorption Method for Determination of Organic Compounds in Water," Journal of the Mississippi Academy of Science, Supplement 24, 23, 1980.

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Fred L. Shore

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Smith, R.W. and F.L. Shore, "Water Hyacinths of Removal of Mirex from Water," Journal of the Mississippi Academy of Science, Supplement 23, 22, 1978.

Quality Assurance Plan, QAD-LEM-37 Evaluation of GC Method for Chlorinated Herbicides (Method 8150), February 1984.

Work Plan, Evaluation of Gas Chromatography Method for Chlorinated Herbicides (Method 8150), December 1983.

Literature Review and Comments on Method 8150, A Gas Chromatographic Method for Analysis of Chlorinated Herbicides, December 1983.

Standard Operating Procedure, QAD-LEM-34 Preparation of Pesticide/Organic Sample Solutions and DSC Standards in Containment Area, October 1983.

Quality Assurance Plan, QAD-LEM-32 Support to Quality Assurance Program for Analysis of Biological Tissues and Fluids for Biological Tissues and Fluids for Organic Toxicants, September 1983.

Final Report - J.O. 74.27, Task 2 PCB congeners in chlorobenzene, Support to Quality Assurance Program for Analysis of Biological Tissues and Fluids for Organic Toxicants (with J. Martin), August 1983.

Final Report - J.O. 74.18, Task 1.0 Interlaboratory Comparison Samples, Technical Support for the Pesticide Quality Assurance Program, December 1982.

Standard Operating Procedure, QAD-LEM-21 Interlaboratory Comparison Samples, November 1982.

Standard Operating Procedure, QAD-LEM-22 Pesticides/Organics Certification, November 1982.

Standard Operating Procedure, QAD-LEM-23 Materials and Supplies Evaluation, November 1982.

Quality Assurance Plan, QAD-LEM-20 Technical Support for the Pesticide Quality Assurance Program, November 1982.

Safety Plan - Technical Support for the Pesticide Quality Assurance Program, August 1982.

Final Report - J.O. 74.18, Task 2, Part I Technical Support for the Pesticide Quality Assurance Program, Interlaboratory Comparison Samples, August 1982.

Fred L. Shore

PAPERS PRESENTED AT MEETINGS:

Shore, F.L., T.W. Campbell, D.A. Hayes, V.A. Fishman, and E.D. Hardin, "Isomer Group Quantitation of Incidentally Generated Polychlorinated Biphenyls, Dioxins and Dibenzofurans Using Gas Chromatography/Mass Spectrometry," Montech '86 Conference on PCB's and Replacement Fluids, 1986.

Shore, F.L. and T.W. Campbell, "Loss of Decafluorotriphenyl Phosphine (DFTPP) from Spiked Environmental Samples," American Chemical Society National Meeting, 1986.

Shore, F.L., T.W. Campbell, M.C. Shepherd, and P.J. Schrynemeeckers, "Special Problems and Solutions for Environmental GC/MS Analysis," Central Texas Analytical Instrument Society Meeting, September 1986.

Shore, F.L. and T.W. Campbell, "Chromatography Problems Encountered in Acetone Extracts of Environmental Samples," American Chemical Society National Meeting, 1986.

Hardin, E.D., P.B. Stewart, T.W. Campbell, D.A. Hayes, A.W. Nichols and F.L. Shore, "An Evaluation of Capillary Columns for the GC/MS Analysis of Polychlorinated Dibenzodioxins and Dibenzofurans in Dielectric Fluids," American Society for Mass Spectrometry, 34th Annual Conference, June 1986.

Campbell, T.W., D.A. Hayes, S.K. Mertens, L.D. Garretson, V.A. Fishman, F.L. Shore, "Analysis of Polyurethane--Florisil Cartridges to Monitor Polychlorinated Biphenyls in Ambient Air," APCA/EPA Symposium on Measurement of Toxic Air Pollutants, April 1986.

Shore, F.L., "Precision of Herbicide Analysis in Hazardous Wastes," presented at the Twenty-Fourth Annual Meeting on the Practice of Chromatography, ASTM Committee E-19, 1985.

Gurka, D.F., F.L. Shore, E.N. Amick, and S.T. Pan, "Single-Laboratory Validation of a Method to Determine Herbicide Esters in Solid Wastes," ACS/SAS Pacific Conference on Chemistry and Spectroscopy, 1985.

Gurka, D.F., F.L. Shore, E.N. Amick, and S.T. Pan, "Single-Laboratory Validation of a Method to Determine Free Acid Herbicides in Hazardous Wastes," American Chemical Society National Meeting, 1985.

Shore, F.L., "Futures through Chemistry: Charting a Course," Third Annual Awards Banquet, American Chemical Society Boulder Dam Section, 1985.

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Johnson, R.L., G.W. Sovocool, E.J. Kantor, E.N. Amick, A.R. Bujold, and F.L. Shore, "Differential Scanning Calorimetry for Purity Measurement of

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Pesticides/Organics of the EPA Reference Standards Repository," American Chemical Society National Meeting, 1985.

Marsden, P.J., F.L. Shore, L.R. Williams, and V. Bohman, "Analysis of Proposed Performance Evaluation Standards Containing Biologically Incorporated Chlorophenols," Annual Meeting of the Association of Official Analytical Chemists, 1984.

Shore, F.L., E.N. Amick, J.D. Martin, and G.W. Sovocool, "Verification of Identity and Purity of Standards of the EPA Pesticide and Industrial Chemical Repository," American Chemical Society National Meeting, 1983.

Agaskar, P., J. Kilgore, and F.L. Shore, "DDT Metabolism by the Microsomal Fraction of the Water Hyacinth Leaf," Mississippi Midwinter Chemical Symposium, Mississippi State University, 1981.

Shore, F.L., N. Abel-Rahim, and D.O. O'Keefe, "Water Hyacinth Metabolism of Mirex," Annual Meeting of the Society of Environmental Toxicology and Chemistry, 80-81, 1980.

Shore, F.L. and R.J. Guillory, "Aryl Azido B-Alanine as a Photoaffinity Probe of Membrane Protein Activity," Journal of the Mississippi Academy of Science, Supplement 24, 1980.

Mayfield, B. and F.L. Shore, "XAD Resin Adsorption Method for Determination of Organic Compounds in Water," Journal of the Mississippi Academy of Science, Supplement 24, 23, 1980.

Shore, F.L., "Organic Chemistry by a Modified Keller Plan," Journal of the Mississippi Academy of Science, Supplement 23, 95, 1978.

Smith, R.W. and F.L. Shore, "Water Hyacinths of Removal of Mirex from Water," Journal of the Mississippi Academy of Science, Supplement 23, 22, 1978.

Amick, E.N., S.T. Pan, A.R. Bujold, F.L. Shore, and G.W. Sovocool, "Analysis of Ethylene Dibromide in Environmental Soil and Water Samples," ACS/SAS Pacific Conference on Chemistry and Spectroscopy, 1985.

Smith, R.W., W. VanZandt, and F.L. Shore, "Water Hyacinths for Removal of Toxaphene from Water," Journal of the Mississippi Academy of Science, Supplement 22, 20, 1977.

HONORARY AND PROFESSIONAL/TECHNICAL SOCIETIES:

American Chemical Society (ACS)
Past Chairman (1985) of Boulder Dam Section of ACS
American Association for the Advancement of Science
American Society for Mass Spectrometry

RADIAN
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FRANCIS J. SMITH

EDUCATION:

M.S., Sanitary Engineering, Massachusetts Institute of Technology, 1954.

B.S., Civil Engineering, University of Michigan, 1950.

EXPERIENCE:

Senior Program Manager, Research and Engineering Operations, Radian Corporation, McLean, VA, 1985-Present.

Program Manager, Research and Engineering Operations, Radian Corporation, McLean, VA, 1981-1985.

Senior Associate, Occupational Health and Safety and Environmental Engineering, A.T. Kearney Management Consultants, Alexandria, VA, 1980-1981.

Acting Chief Environmental Planning, Logistics and Engineering, Headquarters USAF, Washington, DC, 1979-1980.

Chief Environmental Policy, Logistics and Engineering, Headquarters USAF, Washington, DC, 1976-1979.

Director Environmental Protection, Air Force Systems Command (AFSC), Andrews Air Force Base, MD, 1972-1976.

Chief Bioenvironmental Engineering, Headquarters Pacific Air Force, Hickam Air Force Base, HI, 1968-1972.

Similar assignments at Headquarters Alaskan Air Command, Headquarters Tactical Air Command, and at Subcommands of Strategic Air Command, 1951-1968.

Junior Industrial Waste Engineer, Lederle Division, American Cyanamide, Pearl River, NY, 1950-1951.

FIELDS OF EXPERIENCE:

Mr. Smith has had 35 years experience in all aspects of environmental engineering. This experience ranges from carrying out the routine environmental and occupational health operations at individual installations to running the environmental activities of a major federal agency. He is a registered professional engineer, certified industrial hygienist, certified safety professional and is a diplomate of the American Academy of Environmental Engineers.

Mr. Smith is the program manager for the confirmation study of the Marine Corps Training Base at Quantico, Virginia. This is the second phase of the

Francis J. Smith

Navy assessment and control of installation pollutants (NACIP) program for the base. It includes three phases: verification of the existence of groundwater contamination; further characterization, as needed; and preparation of remedial plans and specifications. He was the program manager on the Air Force Engineering and Services Center (AFESC) basic ordering agreement. Mr. Smith was the program manager for four USAF IRP phase 1 record searches. He is also the program manager for the preparation of a hazardous waste management plan, SPCC and other related environmental plans for a Naval air station. He manages a subcontract with a major USA architect-engineer firm for the provision of analytical and technical services in support of groundwater investigations.

He is a section manager in the solid and hazardous waste management business unit of the research and engineering division. Mr. Smith assists the Radian staff in the identification of business opportunities across the seven business units that comprise Radian services. In addition he coordinates all Radian business with DOD in the environmental and occupational health areas. He also participates in the marketing of Radian services to federal agencies and trade associations.

Since retiring from the USAF, Mr. Smith has been involved in a variety of projects including both environmental and health work. The emphasis has been on hazardous waste. They have included assistance in the quality review of reports; health and safety evaluation of cement plants seeking permits to burn chemical wastes; draft environmental impact statement (EIS) on the thermal destruction of chemical wastes; review of the treatment of photographic chemical manufacturing wastes; groundwater contamination studies; RCRA impacts; and an R&D study of truck tire noise for the National Highway Safety Transportation Agency.

He was the certified industrial hygienist (IH) and an environmental consultant for A.T. Kearney Management Consultants. In addition to the routine occupational safety and health activities he specialized in the interpretation and response to the EPA RCRA regulations.

For three of the last four years in his assignment with Headquarters USAF, he was responsible for air, land, and water pollution management programs. This included programming an average of $19 million per year. Also included were: the implementation of RCRA; the initial USAF Installation Restoration Program (IRP, equivalent to CERCLA-Superfund); management of 17 million acres of natural resources; and the National Environmental Policy Act (NEPA) environmental impact analysis program. In addition to these activities, he assumed responsibility for one year for all of Enviromental Planning. This included: comprehensive base planning; the Air Installation Compatibility Use Zone plans for acquiring land near bases with high noise or accident potential; and the development of environmental methodologies.

At the Air Force Systems Command, Mr. Smith organized an office to address effects of the federal environmental laws on the Research, Development and Acquisition programs. (This office was the highest level environmental

activity ever established at a USAF major command.) He directed almost all of the EIS's issued by the USAF in this period. He was an expert witness for the federal government. One was a suit over the health hazards associated with the siting of new type radar stations in California and Massachusetts. The other pertained to an EIS for new facilities in Colorado. Additionally, he was responsible for advising on the industrial hygiene and environmental needs of government owned contractor operated (GOCO) industrial plants.

During his assignment to the Pacific Air Force, Mr. Smith provided environmental and industrial hygiene guidance to USAF activities in Korea, Japan, Taiwan, Vietnam, Thailand, Philippine Islands, Guam, Trust Territories, and Hawaii. This included the traditional areas of sanitary engineering (water supply, treatment, and distribution; waste collection, treatment, and disposal; and pest control). It also included more modern problems, such as LASER equipment calibration, maintenance, and use; handling of large volumes of herbicides; noise control; industrial hygiene; heat and cold extremes; decontamination and quarantine of equipment to prevent introduction of foreign fauna or flora into the U.S. from Asia. For four years, Mr. Smith was a member of the United States delegation to the South East Asia Treaty Organization (SEATO) Military Committee. He represented the U.S. with regard to public health engineering policies. Mr. Smith also evaluated USAF civic action programs to provide basic water and waste disposal to rural Thai villages.

Other USAF assignments in various commands provided environmental engineering and industrial hygiene support for the combat Air Force. Many of the previously mentioned activities were carried out as well as support for the current priority preventive medical activities. Some examples of the latter would be: defense against accidental release or delivery and use of chemical agents; improved water treatment plant operations; improved wastewater facilities and operations; conversion of dumps to sanitary fills; substitution of less toxic materials; and engineering control of working exposures.

CERTIFICATIONS/REGISTRATIONS AND PROFESSIONAL SOCIETIES:

Certified Industrial Hygienist by the American Board of Industrial Hygiene, 1971, No. 690
Certified Safety Professional by the Board of Safety Professionals of the Americas, 1972, No. 2103
Registered Professional Engineer, State of Massachusetts, 1963, No. 19021
Diplomate, American Academy of Environmental Engineers, 1980.

American Industrial Hygiene Association (National and Baltimore-Washington)
American Conference of Government Industrial Hygienists
National (and Maryland) Society of Professional Engineers
American Academy of Industrial Hygiene
American Academy of Environmental Engineers
American Defense Preparedness Association
Air Force Association
Society of Military Engineers

RADIAN
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FRED R. SNYDER

EDUCATION:

B.S., Geological Sciences, University of Texas at Austin, 1982.

EXPERIENCE:

Geologist, Radian Corporation, Austin, TX, 1985-Present.

Geologist, City of Austin, TX, 1983-1985.

Well Logger, Lone Star Logging Co., Ballinger, TX, 1983.

Research Assistant, Bureau of Economic Geology, University of Texas, 1982-1983.

FIELDS OF EXPERIENCE:

At Radian, Mr. Snyder has been involved in several aspects of ground-water investigations. His duties have included the planning of field efforts such as soil and water sampling, geologic logging, and monitor well installation. At Hill AFB, Utah, Mr. Snyder has installed several ground-water monitor wells in the vicinity of waste disposal sites. He has also been responsible for the interpretation of geologic data, and evaluation of soil and water analyses.

While with the City of Austin, Mr. Snyder's responsibilities included the management of an extensive regional geologic information base concerning the Edwards aquifer. He also evaluated ground-water studies and pumping test data (prepared for the creation of municipal utility districts) for the availability and impact on quality of ground water and any adverse effects of surrounding wells. In one program, he managed a survey and statistical analysis of photo derived lineaments with the intention of a better understanding [illegible] subsurface structure and areal variations in fracture porosity of the Edwards aquifer. He participated with the U.S. Geological Survey in precisely [illegible] eating the Edwards aquifer recharge zone. He also acted as co-leader [illegible] Austin Geological Society fall field trip, and co-authored the accompanying guidebook titled "Hydrogeology of the Edwards Aquifer-Barton Springs [illegible] Also, he spoke at the Texas Academy of Science annual convention [illegible] hydrogeology of and protection strategies for the Edwards aquifer.

HONORARY AND PROFESSIONAL SOCIETIES:

American Association of Petroleum Geologists
Austin Geological Society

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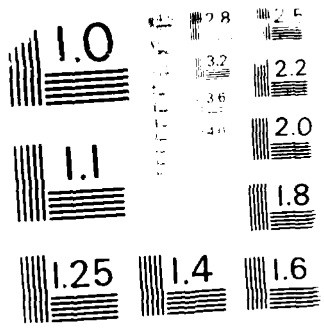
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RADIAN
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TOBIN K. WALTERS

EDUCATION:

B.S., Geology, University of New Mexico, Albuquerque, NM, 1980.

EXPERIENCE:

Hydrogeologist, Radian Corporation, Austin, TX, 1984-Present.

Hydrogeologist, Energy and Minerals Dept., Santa Fe, NM, 1982-1984.

Geologic Consultant, Ville Nueve Resources, Toronto, Canada, 1981-1982.

Exploration Geologist, Occidental Minerals Corp., Lakewood, CO, 1980-1981.

Hydrologic Field Assistant, USGS, WRD Albuquerque, NM, 1979-1980.

FIELDS OF EXPERIENCE

At Radian, Mr. Walters has had extensive experience in studies relating to ground-water hydrology, waste disposal, and environmental impacts. His work has included acquisition of ground water data, assessment of water quality impacts and assessment of geologic and hydrologic environments based upon drill hole information, field tests and existing literature.

Recently, Mr. Walters completed a fly ash investigation with Radian in western New Mexico to assess the hydrologic impacts of ash disposal in the area. The first phase of the study involved setting up a grid coordinate system and shallow coring the ash body to determine the areal extent of the ash. Monitor wells were then installed up-gradient and down-gradient from the ash body. An aquifer test of the ash body and attenuating media adjacent to the ash was performed to determine the aquifer characteristics of the transporting media. A report detailing field and laboratory results including Whole Sample, ASTM leach, and RCRA leach analyses was prepared for the client and incorporated into the permit application.

On another mine hydrology project, Mr. Walters provided hydrologic modeling services to a surface coal mine by analyzing pit inflow to the mine over a 25-year period. Mr. Walters selected a finite-difference, steady-state ground-water model for the study. The model is also used by the Office of Surface Mining regulatory agency (OSM) to define steady-state confined flow to mine pits. Using the model, Mr. Walters assessed the probable hydrologic consequences of extracting coal from the mine pit over a period of 25 years. The results of the hydrologic study were incorporated into the mine permit application.

Previously, Mr. Walters and other Radian geologists directed a ground-water monitoring investigation of an abandoned oil refinery in southern California

to characterize the water quality and extent of contamination, and establish the flow direction beneath the refinery. Mr. Walters supervised the installation of monitor wells and assisted in sampling the wells for organic and inorganic compounds. The results of the investigation were used by the client to respond to applicable State and Federal regulations pertaining to hazardous waste monitoring and waste removal operations.

Mr. Walters was Project Director for a Phase II hydrogeologic investigation of multiple waste disposal sites at Cannon AFB, Clovis, New Mexico. The purpose of the investigation was to determine if environmental contamination had resulted from waste disposal practices, fuel spills/leaks and fire training activities at the base. Four ground water monitor wells were installed into the upper saturated portion of the Ogallala Aquifer and analyzed for contaminants. In addition, 130 soil samples were collected using a hollow stem auger and split spoon sampler from 16 suspected disposal sites at the base. The results of the field investigation were incorporated into a Phase II report by Radian staff under the direction of Mr. Walters.

During the summers of 1984 and 1985 Mr. Walters participated in a similar Phase II study at McClellan AFB, California. His responsibilities included supervising the installation of shallow and deep monitor wells off-base, and down-gradient from suspected base disposal areas. He logged samples and obtained water samples from semi-confined water-bearing zones. His other responsibilities were to secure drilling permits and access agreements from City, County and State authorities prior to start-up operations, and to conduct well inventories of residences near the base.

A hydraulic components manufacturing plant in Joplin, Missouri, contracted Radian to supervise the installation of four RCRA wells and to sample groundwater beneath two leaky waste oil treatment lagoons and several tanks containing cyanide and chromium enriched wastewater. Based on existing geologic maps and drill-hole information gathered during the well installation phase of the study, it was discovered that the area west of the waste management area was the site of an abandoned underground mine. Mr. Walters expanded the drilling program to include an investigation of the mine (abandoned) and installed two additional wells in the mine zone. The results of the study were made available to the company which it used to proceed with closure activities at the waste site.

Mr. Walters is currently working on a ground-water investigation of a former small arms manufacturing plant near Denver, Colorado. The study involves the installation of four monitor wells in an up-gradient and down-gradient configuration adjacent to the site and the collection of soil, water and lake bottom sediment samples. The results of the investigation will be forwarded to the Army Corps of Engineers.

Mr. Walters has participated in other ground-water investigations in Utah, Texas, Oklahoma and California for Radian Corporation.

RADIAN
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Toby K. Walters

Previously, Mr. Walters worked as a hydrogeologist with the Energy and Minerals Department in New Mexico. His main responsibilities were to review hydrology sections of mine permits from coal mines operating, or seeking to operate, in New Mexico. He also enforced State mining regulations. During his term with the State, he inspected and issued permits to all coal mines operating on private and State-owned land. In addition, he assisted the Office of Surface Mining in conducting hydrologic investigations, environmental assessments and cumulative hydrologic impact assessments of coal mines. While at the State he served on the Governor's Hydrologic Task Force. The task force served as advisor to the Secretary of the Energy and Minerals Dept. who developed policy and guidelines pertaining to water use in New Mexico.

As a geologic consultant, Mr. Walters worked in the Gold-Arsenic Belt of Central Nevada where he mapped gold-bearing properties and supervised close-spaced drilling programs to prove claims and develop ore reserve estimates. He supervised several other base and precious metal exploration projects in Arizona and New Mexico. As a consultant, Mr. Walters was also responsible for restoring roads and drill sites, and filing mining claims with appropriate County officials.

After graduating from the University of New Mexico, Mr. Walters worked as an Exploration Geologist for Occidental Minerals Corporation in Lakewood, Colorado. His duties included supervising field activities for an intensive uranium exploration project in New Mexico and Arizona. He mapped sedimentary rocks and logged cuttings and core. While at Oxy, he was also trained in underground safety and worked briefly underground as an ore-grade geologist.

While attending the University of New Mexico, Mr. Walters worked part-time for the United States Geological Survey as a Hydrologic Field Assistant. He assisted in coding data for a finite-difference, steady-state hydrologic model of a southwest alluvial basin in New Mexico. Mr. Walters developed a working understanding of Tertiary Age sediments in the Rio Grande Basin as part of his training with the USGS, and developed a trilinear facies classification system of sediments in the Basin.

CERTIFICATION:

Certified Professional Geological Scientist (CPGS), No. 7139.

HONORARY/TECHNICAL SOCIETIES

Association of Ground Water Scientists and Engineers

PUBLICATIONS

Walters, T.K., Little, W.M., "Geohydrologic Investigation of an Abandoned Oil Refinery in Southern California - Phase II", Radian Corporation, Austin, TX, November 1985.

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CORPORATION

Toby K. Walters

Radian Corporation, "Installation Restoration Program Phase II - Confirmation/Quantification Stage I, Cannon AFB, New Mexico", Radian Corpora n, Austin, TX, June 1985.

Walters, T.K., "Pit Inflow Analysis of a Western Coal Mine in New Mexico," Radian Corporation, Austin, TX, December 1985.

Walters, T.K., "Fly Ash Waste Site Investigation near Farmington, New Mexico," Radian Corporation, Austin, TX, December 1985.

Radian Corporation, "Installation Restoration Program Phase II - Confirmation/Quantification Stage I, McClellan AFB, California," Radian Corporation, Austin, TX, July 1984.

Radian Corporation, "Technical Analysis for McKinley Mine, McKinley County, New Mexico," Radian Corporation, Austin, TX, October 1984.

Floyd, M.P. and Walters, T.K., "Hydrogeologic Investigation of a Hydraulic Components Facility," Joplin, MO, Radian Corporation, August 1984.

Holcombe, L.J. and Walters, T.K., "Solid Waste Management Review for St. Johns River Power Park," Jacksonville, FL, Radian Corporation, May 1986.

/

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CORPORATION

PETER ALEXANDER WATERREUS

EDUCATION:

B.S., Geology, The University of Texas at San Antonio, San Antonio, TX, 1984.

EXPERIENCE:

Geologist, Radian Corporation, Austin, TX, 1984-Present.

Mud Logger, Precision Well Logging, Houston, TX, 1984.

FIELDS OF EXPERIENCE:

Mr. Waterreus is currently involved in the investigation and determination of a JP-4 fuel leak from existing underground pipelines at Bergstrom AFB, Austin, Texas. As supervising geologist, activities include safety supervision, logging borings, collection of soil samples, installation of monitor wells, collection of water samples, and reporting.

Mr. Waterrus also is currently involved in the investigation of hazardous waste contamination at Sheppard AFB, Wichita Falls, Texas. As a supervising geologist, activities include safety supervision, logging borings, collection of soil samples, installation of monitor wells, collection of water samples, monitoring possible types of contamination by use of a photo-ionizer and drager tubes, and reporting.

Mr. Waterreus was involved in the investigation of environmental impact related to gas and oil production in the Big Thicket area of East Texas. Activities includes delineation and mapping of active and non-active gas and oil well sites as well as damaged areas outside the site area.

At Precision Well Logging, he performed analyses of rock cuttings with respect to lithology and oil content as well as gas monitoring and identification.

He has also been involved in field mapping and property investigation in Uvalde County, Texas.

PUBLICATIONS:

Waterreus, P.A. and R.A. Wooster, "A Feasibility Study of Inducing Artificial Recharge to the Edwards Aquifer by Diversion of Floodwaters in Uvalde County, Texas," on record at the Edwards Underground Water District, San Antonio, Texas.

HONORARY AND PROFESSIONAL SOCIETIES:

Geologic Society of America.
Association of Ground Water Scientists and Engineers.

02/26/85

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RADIAN CORPORATION

APPENDIX I

Results of Terrain Conductivity and Soil Gas Surveys

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TERRAIN CONDUCTIVITY SURVEY

Radian utilized the services of a subcontractor, Delta Geophysical Services, to accomplish the terrain conductivity surveys at AF Plant 4. An edited report of the subcontractor is presented in this appendix. The report was edited to present only those results dealing with activities requested by the statement of work. Geophysical recommendations or conclusions that went beyond those actions requested in the scope or that were not consistent with results of direct drilling and geological exploration in the study areas were disregarded. The subcontract statement of work is presented below.

STATEMENT OF WORK

The contractor will provide equipment, operators, and all materials necessary to perform geophysical (electromagnetic) surveys at Air Force Plant 4, near Fort Worth, Texas. The geophysical surveys to be performed are part of the field activities scheduled for the Installation Restoration Program at AF Plant 4. Radian has overall responsibility for the performance of the field investigations at AF Plant 4.

The purpose of the geophysical surveys is to define the areas of waste disposal, determine if plumes of contaminated ground water are present, and provide guidance on the selection of monitor well sites. A total of three locations (Sites 2, 3, and 5), identified on the attached figure, will be surveyed. These locations correspond to landfills and fire training areas. The program is summarized by location, activity, and purpose on the attached table.

SUMMARY OF GEOPHYSICAL PROGRAM

Location	Concern	Activity	Purpose	Dimensions
Site 2	Landfill	Electromagnetic Profiling	Define waste and plume boundaries, determine thickness and permeability distribution in alluvium.	Area apx.800'x1800' Depth apx.45' (1)
Site 3	Landfill	Electromagnetic Profiling	Define waste and plume boundaries, determine thickness and permeability distribution in alluvium.	Area apx.500'x3000' Depth apx. 15'
Site 5	Fire Training Area Fuel Spills	Electromagnetic Profiling	Define thickness and permeability distribution in alluvium.	Area apx.250'x250' Depth apx.15'

NOTES: (1) Depth corresponds to the approximately base of the alluvium.

TERRAIN CONDUCTIVITY SURVEY

Air Force Plant 4
Fort Worth, Texas

for

Radian Corporation
Austin, Texas

Performed by
Delta Geophysical Services

January 6, 1985

Edited Report of
Delta Geophysical Services
116 West Main Street
Clinton, New Jersey 08809

We have completed the terrain conductivity surveys at Air Force Plant 4 located in Fort Worth, Texas.

Initial activities included control gridding of three sites (Landfill #2, Landfill #3 and Fire Training Area #2) prior to each conductivity survey in addition to gathering site-specific data (historical data, etc.).

Control gridding was established with a 300-foot measuring tape using appropriate reference points (buildings, roads, etc.). Within each survey area, baselines were established. Wooden stakes were driven into the ground at 30-foot intervals along each baseline. Conductivity data were collected at 30-foot stations perpendicular to the baselines. This provided us with a 30 by 30-foot data base for each area so accurate subsurface conditions could be mapped and evaluated.

PROGRAM

A Geonics EM-34 terrain conductivity meter was used to measure subsurface conductance (mmhos/m). In order to evaluate boundary conditions and types of subsurface material present beneath each area, conductivity data were gathered from an effective depth of 45-feet. To identify plumes of contamination migrating from each site area, conductivity data were collected from two effective depths: 45- and 90-feet.

TERRAIN CONDUCTIVITY SURVEY

The conductivity map (in pocket) shows seven types of anomalous zones with corresponding shadings. The terrain conductivity survey map also shows the survey lines, base lines, interpreted underground utility lines, and reference points. The undefined symbols on the map refer to discarded subcontractor recommendations.

Interpretation of the conductivity data included interpretive contouring (relative to external interferences), line profiling, data base evaluation and conductivity signature interpretation. Profiles and a data listing of each conductivity line are included in the Annex.

LANDFILL #2

This is the largest of the three areas and is located between Bomber Plant Road and the active radar testing area. This area measured the most severe change and/or range in conductivities. Conductivity values generally increase from the northeast to the southwest.

A moderately large zone was found in the northeastern part of the survey area. Southwest of this area (around well HM-43), high conductivity values were recorded.

LANDFILL #3

This area is located north of landfill area #2 between Bomber Plant Road and the creek. Recorded conductivity values for this area reflect no major conductivity trends. There are however, large anomalous areas.

FIRE TRAINING AREA #2

This area is located in the parking lot west of the material management center. The conductivity values recorded from this area indicate two large anomalous zones and one small anomalous zone.

The report was signed on behalf of Delta Geophysical Services by Philip H. Duoos, Geophysical Engineer and Drew A. Gould, Vice President.

ANNEX

LANDFILL #2

CONDUCTIVITY VALUES FOR
LINE:A

Horizontal
36.0
52.0
45.0
45.0
46.0
48.0
47.0
44.0
43.0
40.0
39.0
39.0
36.0
20.0
22.0
35.0
33.0
28.0
32.0
29.0
35.0
35.0
38.0
38.0
38.0
38.0
39.0
40.0
42.0
42.0
42.0
42.0
42.0
41.0

CONDUCTIVITY VALUES FOR
LINE:RAB

Horizontal
61.0
58.0
57.0
56.0
55.0
55.0
57.0
58.0
41.0
55.0
54.0
54.0
51.0
52.0
46.0
44.0
44.0
41.0
42.0
40.0
42.0
42.0
40.0
37.0
23.0
21.0
31.0
31.0
32.0
30.0
33.0
33.0
35.0
36.0
38.0
39.0
40.0
41.0
42.0
41.0
43.0
44.0
43.0
42.0
38.0

CONDUCTIVITY VALUES F
LINE:RAC

Horizontal
60.0
42.0
64.0
63.0
55.0
58.0
58.0
56.0
54.0
53.0
52.0
49.0
46.0
43.0
40.0
42.0
40.0
42.0
44.0
42.0
39.0
37.0
39.0
29.0
24.0
31.0
28.0
27.0
27.0
26.0
23.0
24.0
27.0
35.0
37.0
39.0
39.0
38.0
38.0
40.0
39.0
39.0
36.0
36.0

CONDUCTIVITY VALUES FOR LINE:RAD	CONDUCTIVITY VALUES FOR LINE:RAE	CONDUCTIVITY VALUES FOR LINE:RAF
Horizontal	Horizontal	Horizontal
43.0	58.0	51.0
60.0	60.0	57.0
60.0	60.0	60.0
57.0	60.0	55.0
60.0	57.0	56.0
60.0	58.0	58.0
60.0	58.0	63.0
59.0	58.0	62.0
56.0	59.0	65.0
57.0	59.0	62.0
54.0	60.0	60.0
52.0	58.0	52.0
50.0	56.0	57.0
48.0	51.0	55.0
47.0	50.0	55.0
47.0	46.0	50.0
44.0	44.0	48.0
40.0	40.0	45.0
39.0	37.0	40.0
36.0	33.0	37.0
36.0	31.0	35.0
34.0	32.0	33.0
34.0	34.0	32.0
32.0	37.0	32.0
36.0	27.0	35.0
29.0	27.0	27.0
22.0	36.0	25.0
28.0	34.0	33.0
34.0	34.0	32.0
28.0	41.0	35.0
24.0	40.0	33.0
18.0	42.0	33.0
18.0	53.0	30.0
24.0	36.0	29.0
23.0	47.0	31.0
26.0	41.0	30.0
29.0	40.0	32.0
34.0	36.0	30.0
35.0	34.0	34.0
39.0	34.0	39.0
36.0	33.0	36.0
40.0	36.0	35.0
38.0	36.0	35.0
37.0	37.0	34.0
37.0	36.0	34.0
36.0		37.0
37.0		39.0

CONDUCTIVITY VALUES FOR LINE:RAG

Horizontal
20.0
13.0
20.0
24.0
0.0
44.0
27.0
38.0
46.0
47.0
43.0
47.0
50.0
54.0
55.0
54.0
53.0
49.0
48.0
47.0
62.0
0.0
24.0
26.0
0.0
20.0
31.0
30.0
29.0
28.0
32.0
31.0
30.0
30.0
32.0
32.0
30.0
28.0
29.0
30.0
33.0
35.0
36.0
38.0
38.0
38.0

CONDUCTIVITY VALUES FOR LINE:RAH

Horizontal	
52.0	
51.0	
47.0	
52.0	
54.0	
54.0	
55.0	
57.0	
60.0	
60.0	
54.0	
50.0	
52.0	
47.0	
47.0	
48.0	
42.0	
43.0	
0.0	
0.0	
0.0	
0.0	SKIP
0.0	(BLDG #180)
0.0	
0.0	
0.0	
34.0	
34.0	
30.0	
30.0	
27.0	
27.0	
26.0	
29.0	
29.0	
30.0	
33.0	
34.0	
36.0	
40.0	
41.0	
45.0	
45.0	

CONDUCTIVITY VALUES FOR LINE:RAI

Horizontal	
46.0	
44.0	
50.0	
48.0	
48.0	
53.0	
56.0	
54.0	
54.0	
54.0	
58.0	
61.0	
53.0	
56.0	
50.0	
50.0	
48.0	
0.0	- SKIP
44.0	
0.0	
0.0	
0.0	SKIP
0.0	(BLDG #180)
0.0	
0.0	
0.0	
19.0	
20.0	
20.0	
23.0	
24.0	
32.0	
33.0	
33.0	
33.0	
32.0	
36.0	
38.0	
40.0	
38.0	
34.0	
32.0	

CONDUCTIVITY VALUES FOR
LINE:RAJ

Horizontal
60.0
61.0
61.0
58.0
51.0
30.0
27.0
10.0
51.0
51.0
53.0
62.0
60.0
62.0
62.0
50.0
44.0
50.0
49.0
46.0
43.0
37.0
42.0
0.0
0.0
0.0 Skip
0.0
0.0
34.0
33.0
35.0
35.0
31.0
30.0
30.0
31.0
32.0
30.0
29.0
35.0
33.0
43.0
34.0
34.0

CONDUCTIVITY VALUES FOR
LINE:RAK

Horizontal
63.0
62.0
63.0
64.0
66.0
66.0
67.0
66.0
66.0
64.0
63.0
62.0
61.0
60.0
60.0
58.0
55.0
52.0
50.0
47.0
57.0
50.0
43.0
42.0
49.0
25.0
36.0
49.0
38.0
43.0
40.0
43.0
10.0
28.0
24.0
34.0
26.0
36.0
36.0
31.0
20.0
32.0
35.0
30.0
32.0
31.0
36.0
34.0

CONDUCTIVITY VALUES FOR
LINE:RAL

Horizontal
61.0
64.0
65.0
67.0
67.0
68.0
67.0
67.0
67.0
66.0
66.0
63.0
63.0
63.0
63.0
62.0
60.0
58.0
55.0
52.0
52.0
54.0
56.0
56.0
54.0
53.0
50.0
48.0
47.0
46.0
46.0
35.0
43.0
22.0
33.0
53.0
24.0
16.0
1.0
25.0
44.0
36.0
38.0
38.0
36.0
30.0
32.0
30.0
35.0
36.0
29.0

CONDUCTIVITY VALUES FOR LINE:RAM	CONDUCTIVITY VALUES FOR LINE:RAN	CONDUCTIVITY VALUES FOR LINE:RAO
Horizontal	Horizontal	Horizontal
64.0	63.0	63.0
65.0	64.0	63.0
66.0	66.0	63.0
67.0	67.0	65.0
67.0	69.0	64.0
66.0	67.0	66.0
66.0	67.0	66.0
65.0	67.0	67.0
64.0	68.0	68.0
64.0	65.0	68.0
64.0	65.0	68.0
64.0	66.0	67.0
64.0	66.0	67.0
63.0	66.0	67.0
63.0	66.0	66.0
61.0	67.0	67.0
61.0	67.0	68.0
57.0	66.0	68.0
52.0	64.0	68.0
51.0	58.0	66.0
54.0	54.0	67.0
54.0	54.0	67.0
57.0	54.0	66.0
56.0	56.0	64.0
55.0	57.0	56.0
53.0	57.0	54.0
53.0	56.0	53.0
50.0	55.0	54.0
48.0	52.0	53.0
44.0	50.0	54.0
39.0	46.0	54.0
39.0	46.0	53.0
43.0	47.0	48.0
46.0	49.0	43.0
46.0	46.0	42.0
46.0	45.0	40.0
42.0	46.0	40.0
46.0	56.0	37.0
45.0	53.0	40.0
34.0	56.0	37.0
40.0	55.0	42.0
32.0	54.0	44.0
32.0	50.0	49.0
36.0	48.0	48.0
36.0	46.0	52.0
48.0	54.0	71.0
	76.0	

CONDUCTIVITY VALUES FOR
LINE:RAP

Horizontal
60.0
60.0
63.0
65.0
67.0
68.0
69.0
69.0
70.0
69.0
69.0
69.0
68.0
67.0
68.0
69.0
70.0
71.0
72.0
72.0
71.0
71.0
71.0
71.0
70.0
63.0
58.0
54.0
55.0
54.0
54.0
55.0
56.0

CONDUCTIVITY VALUES FOR
LINE:RAO

Horizontal
61.0
60.0
60.0
61.0
61.0
63.0
64.0
64.0
67.0
68.0
69.0
70.0
70.0
68.0
68.0
66.0
67.0
67.0
69.0
70.0
69.0
70.0
69.0
70.0
71.0
70.0
68.0
66.0
60.0
50.0
53.0
51.0
53.0
120.0

CONDUCTIVITY VALUES FOR
LINE:RAR

Horizontal
61.0
62.0
63.0
63.0
63.0
64.0
65.0
66.0
68.0
70.0
70.0
72.0
73.0
74.0
73.0
73.0
71.0
72.0
70.0
73.0
71.0
72.0
75.0
74.0
73.0
76.0
82.0
83.0

ONDUCTIVITY VALUES FOR
LINE:RAX1

Horizontal
51.0
50.0
50.0
50.0
48.0
45.0
41.0
41.0
42.0
48.0
51.0
46.0
46.0
45.0
49.0
50.0
47.0
51.0
45.0
50.0

CONDUCTIVITY VALUES FOR
LINE:RAX2

Horizontal
32.0
32.0
28.0
39.0
41.0
42.0
45.0
44.0
44.0
45.0
49.0
47.0

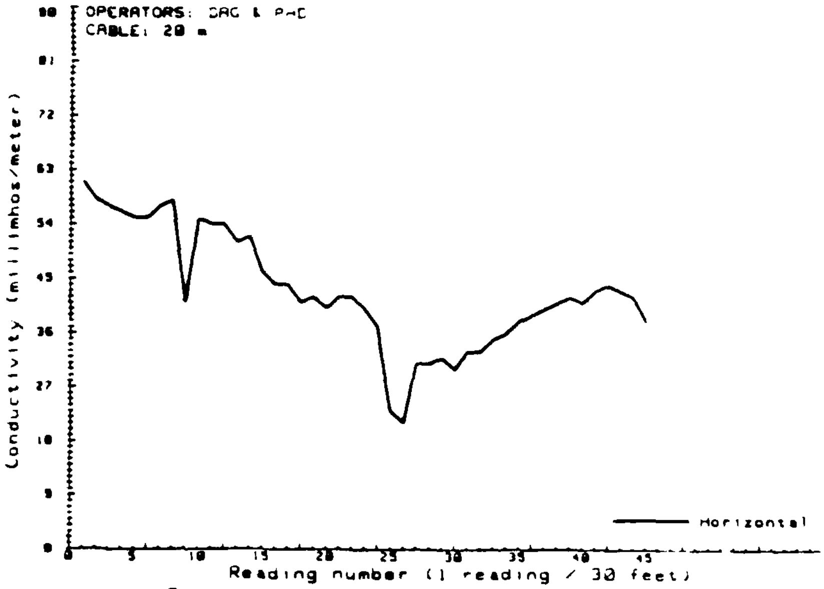
ONDUCTIVITY VALUES FOR
LINE:RAT1

Horizontal
61.0
54.0
58.0
52.0
49.0
47.0
47.0
49.0
53.0
55.0
57.0
58.0

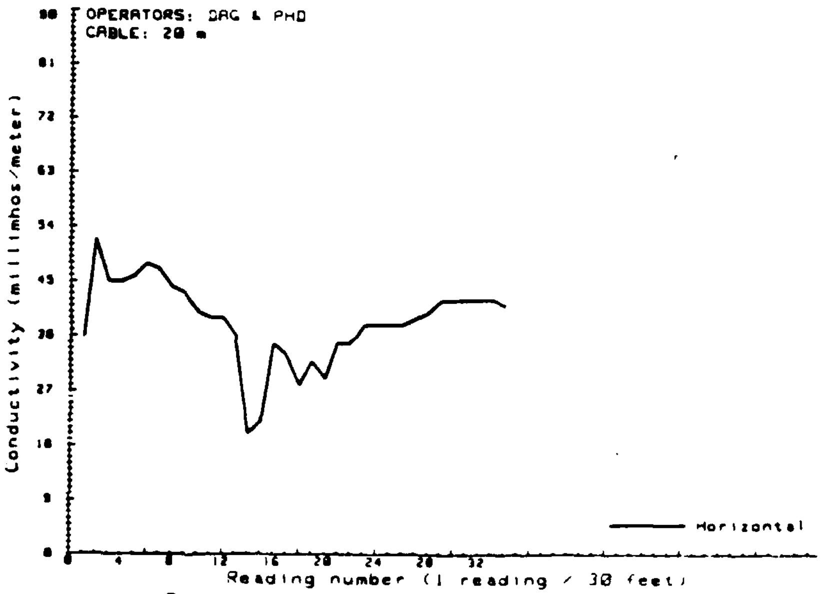
ONDUCTIVITY VALUES FOR
LINE:RAT2

Horizontal
47.0
49.0
48.0
53.0
47.0
34.0
69.0

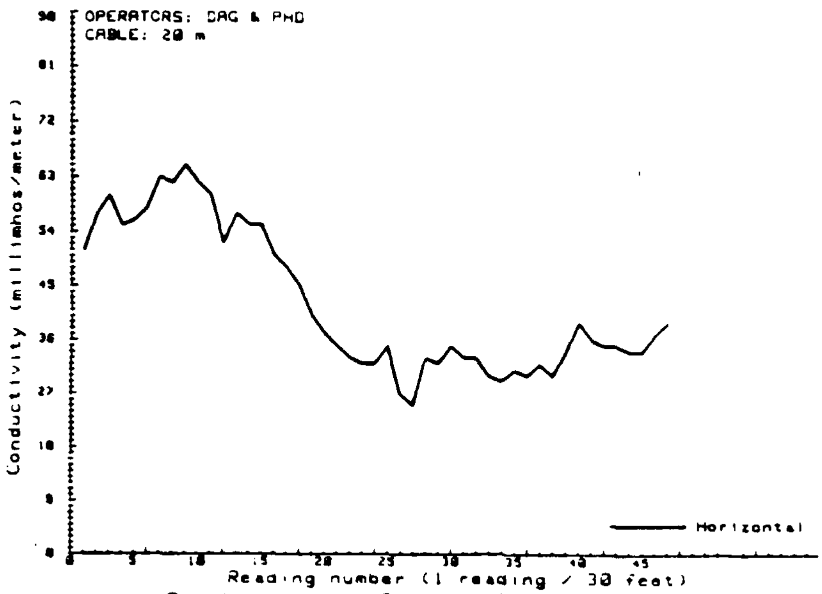
Conductivity Graph of Line: RAC



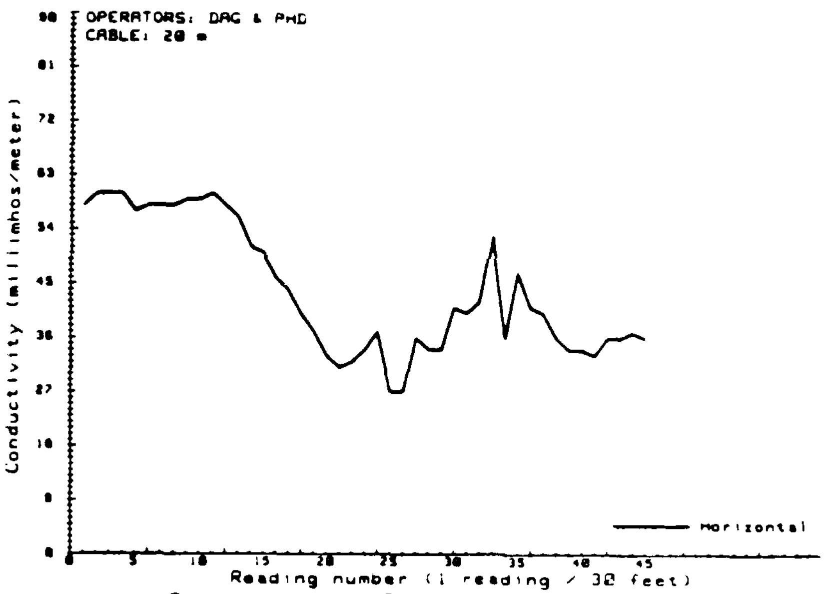
Conductivity Graph of Line: RAB



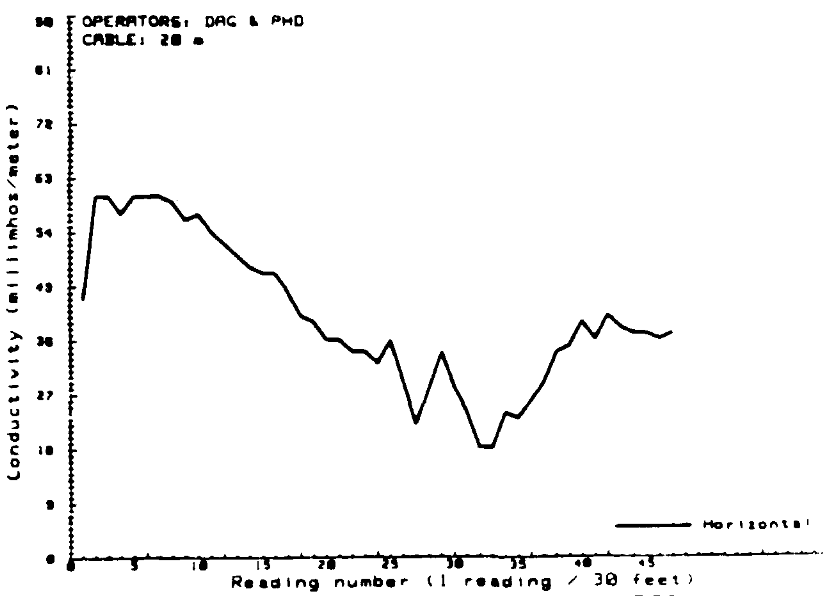
Conductivity Graph of Line: A



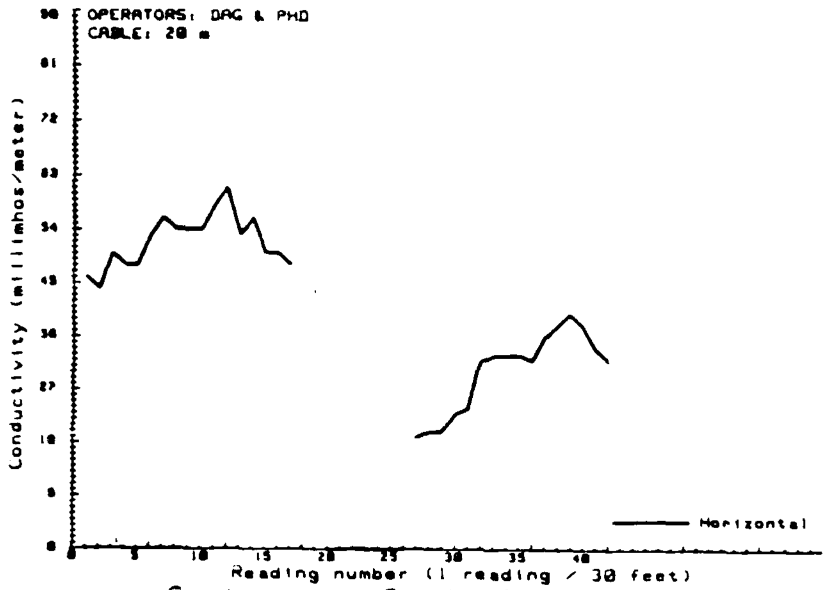
Conductivity Graph of Line: RAF



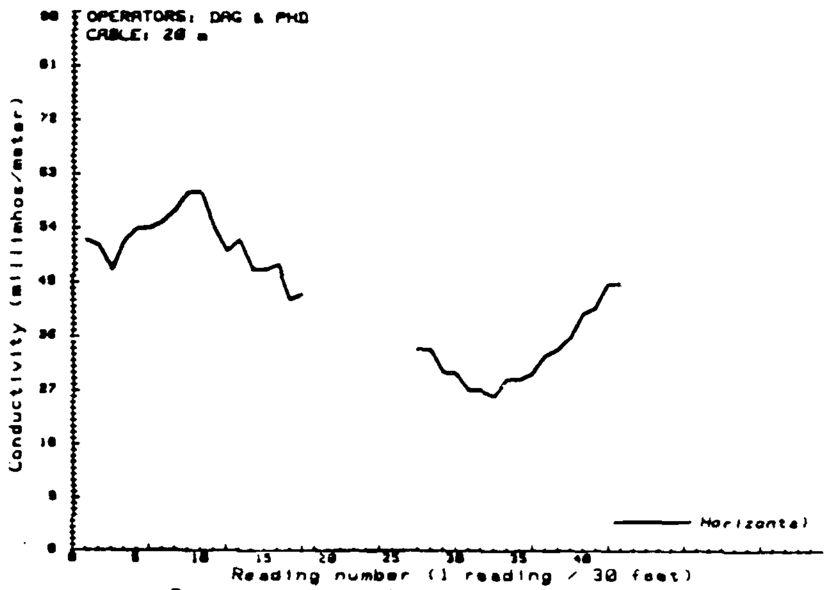
Conductivity Graph of Line: RAE



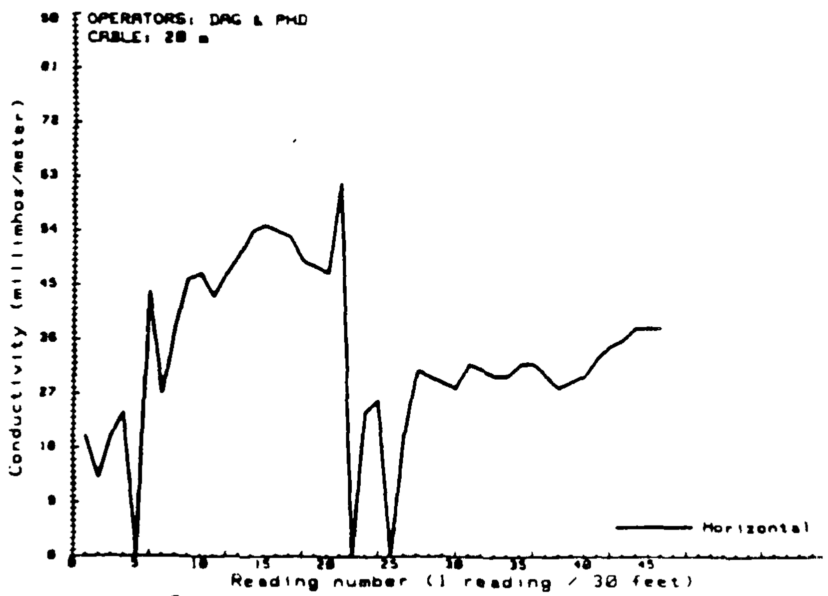
Conductivity Graph of Line: RA



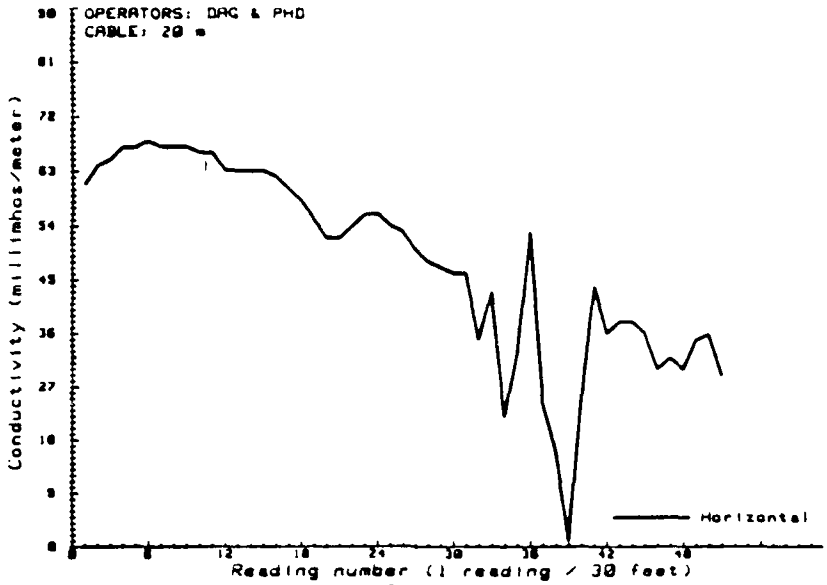
Conductivity Graph of Line: RAI



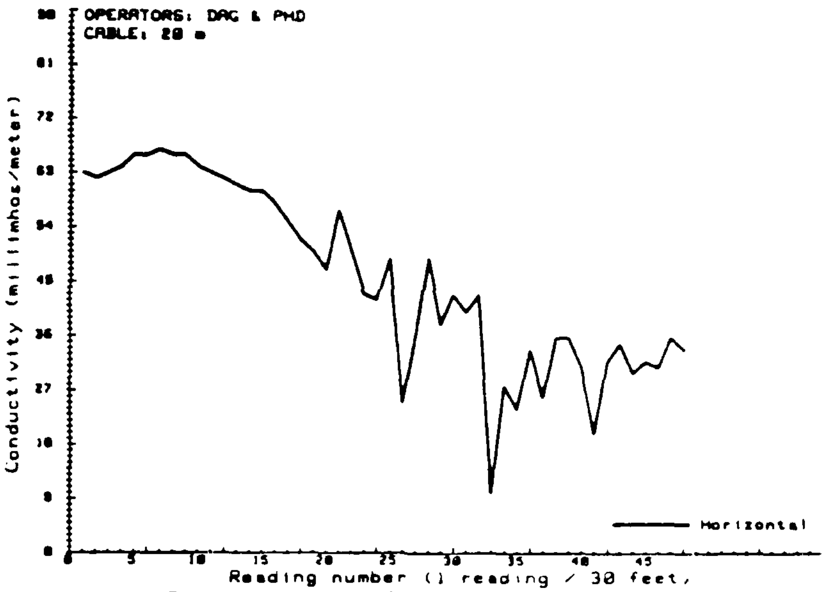
Conductivity Graph of Line: RAH



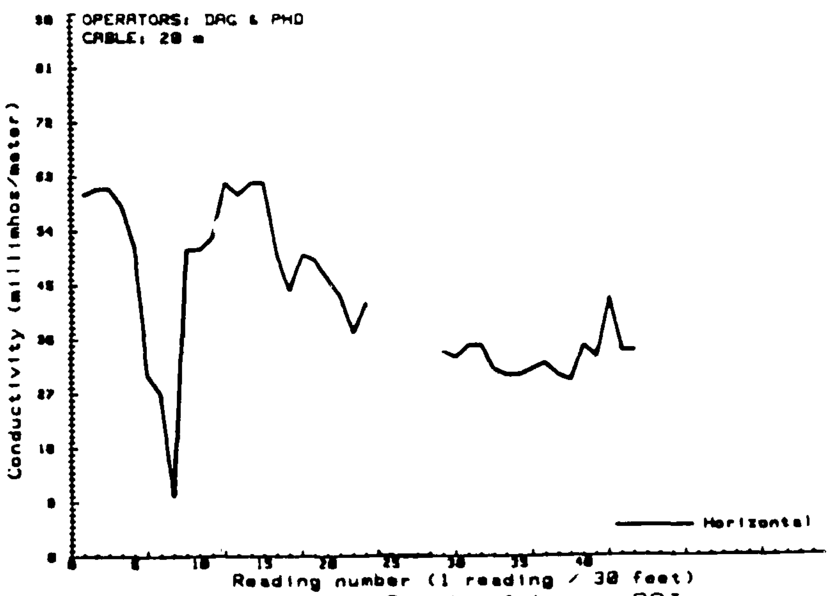
Conductivity Graph of Line: RAG



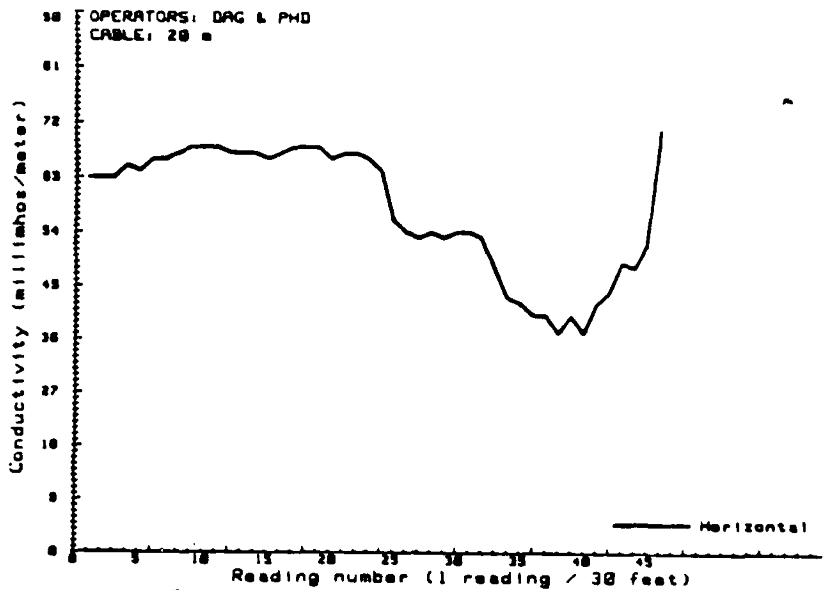
Conductivity Graph of Line: RAL



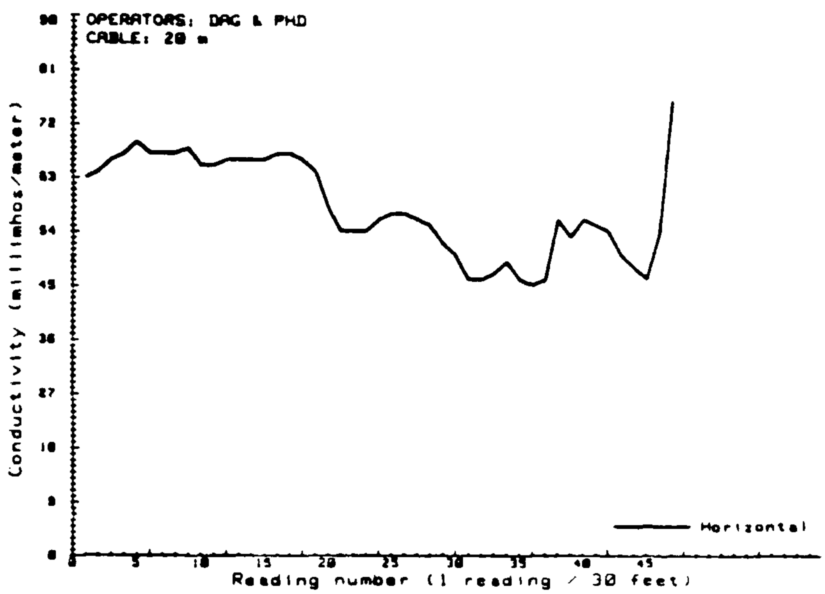
Conductivity Graph of Line: RAK



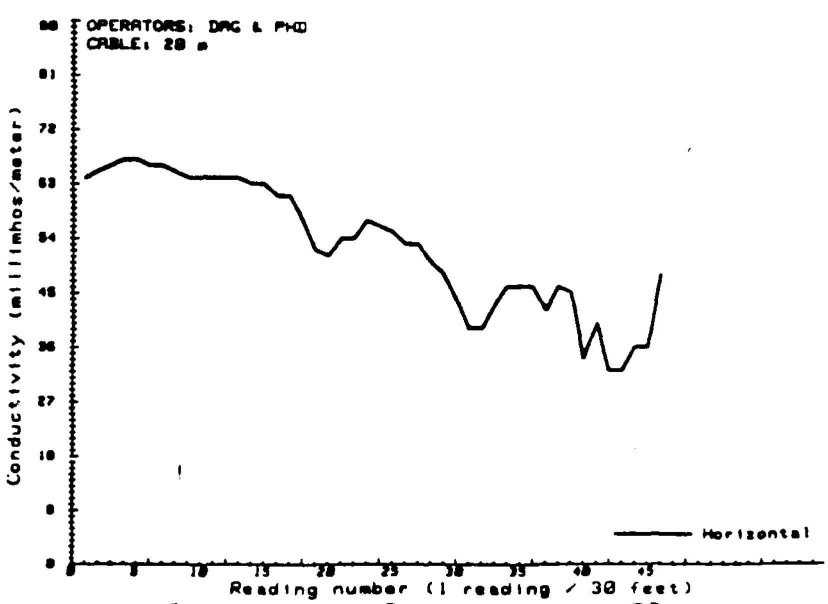
Conductivity Graph of Line: RAJ



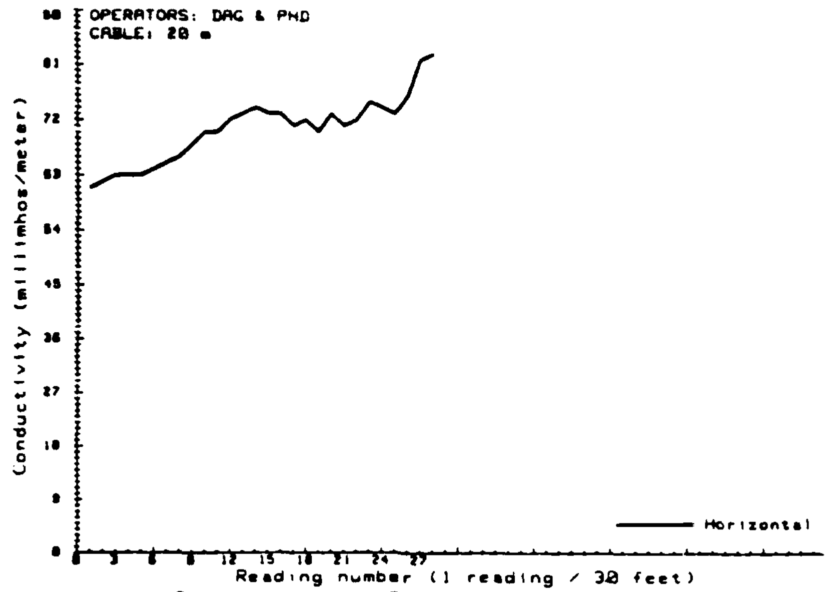
Conductivity Graph of Line: RAO



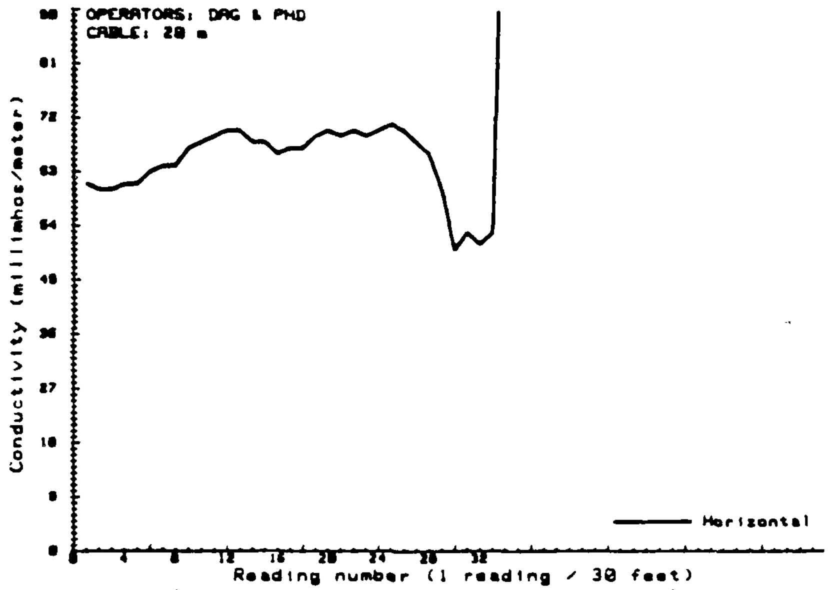
Conductivity Graph of Line: RAN



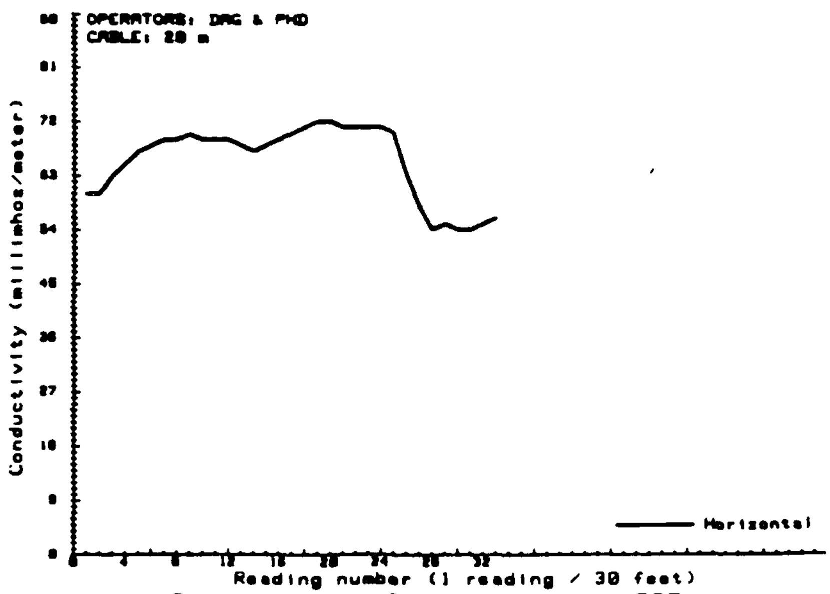
Conductivity Graph of Line: RAM



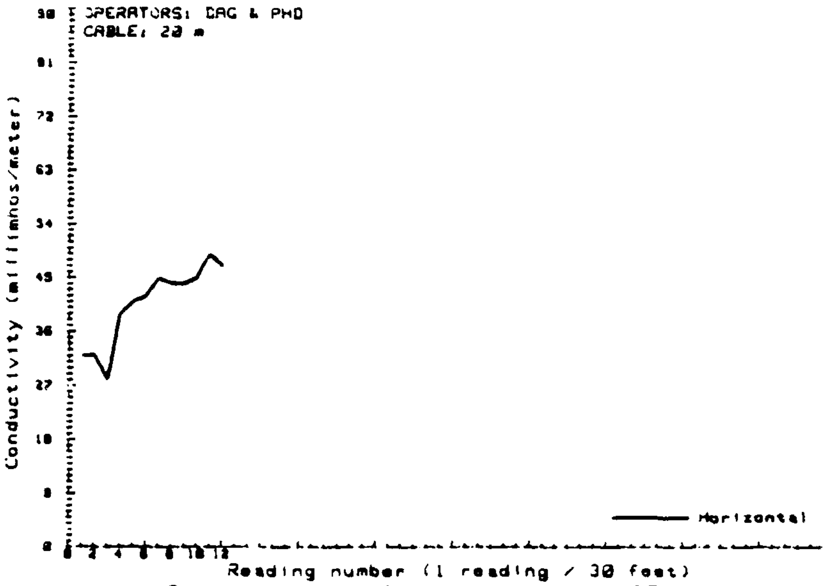
Conductivity Graph of Line: RAR



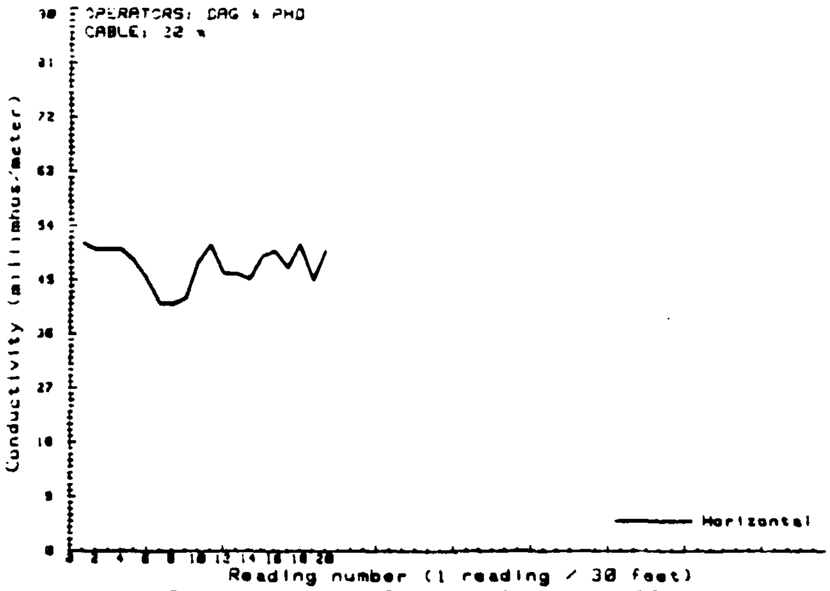
Conductivity Graph of Line: RAQ



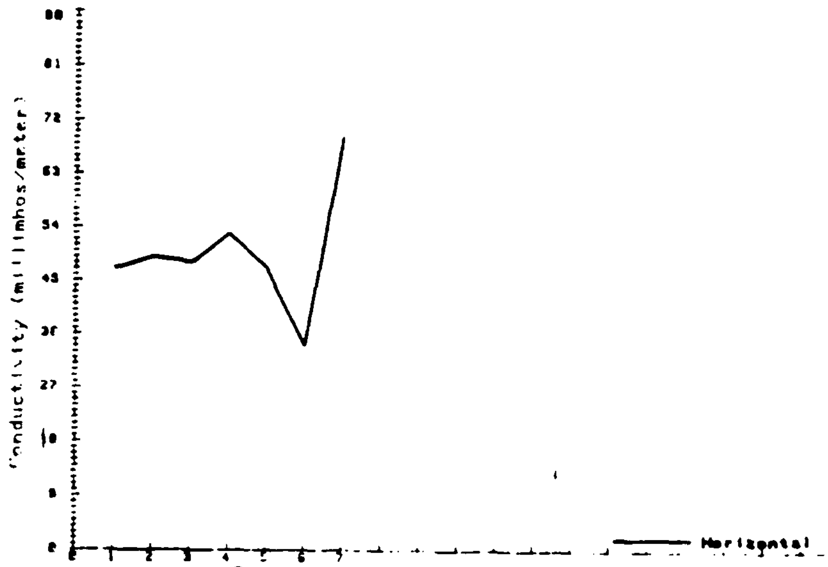
Conductivity Graph of Line: RAP



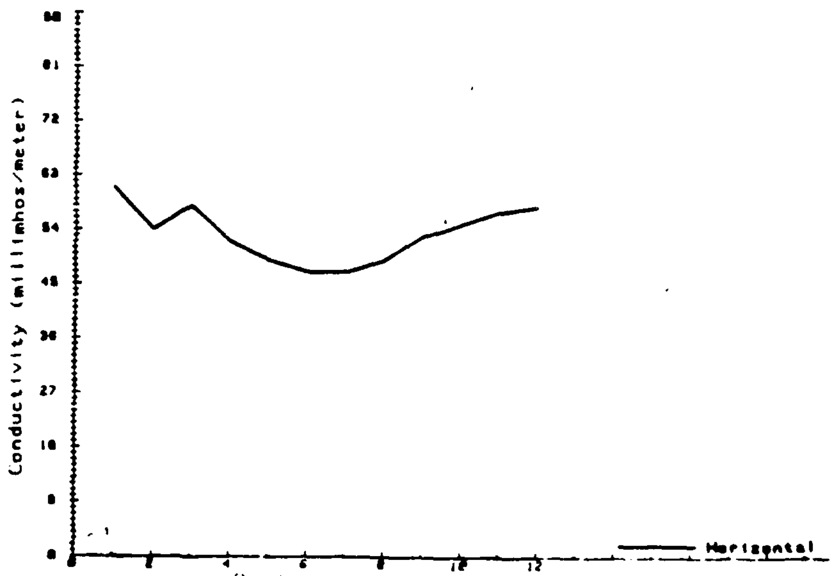
Conductivity Graph of Line: RAX2



Conductivity Graph of Line: RAX1



Conductivity Graph of Line: RHT2



Conductivity Graph of Line: RHT1

LANDFILL #3

ONDUCTIVITY VALUES FOR
LINE:RA3A

Horizontal
36.0
36.0
38.0
38.0
38.0
39.0
38.0
40.0
34.0
33.0
33.0
34.0
36.0
38.0
36.0
37.0
38.0
36.0
34.0
30.0
29.0
28.0
28.0
29.0
29.0
29.0
30.0
29.0
30.0
30.0
31.0
31.0
33.0
32.0
31.0
32.0
33.0
32.0
32.0
31.0
30.0
30.0
29.0
30.0
29.0
30.0
29.0
28.0
28.0
28.0
29.0
30.0

CONDUCTIVITY VALUES FOR
LINE:RA3B

Horizontal
32.0
34.0
36.0
36.0
37.0
38.0
38.0
40.0
37.0
35.0
32.0
32.0
31.0
31.0
31.0
33.0
34.0
35.0
34.0
33.0
30.0
30.0
31.0
30.0
31.0
30.0
29.0
28.0
30.0
31.0
33.0
33.0
32.0
32.0
33.0
33.0
33.0
34.0
33.0
33.0
33.0
32.0
38.0
30.0
30.0
30.0
29.0
28.0
29.0
29.0
28.0
29.0
32.0 ← Value from RAP6

CONDUCTIVITY VALUES FOR
LINE:RA3C

Horizontal
40.0
39.0
35.0
35.0
33.0
34.0
36.0
37.0
36.0
33.0
33.0
31.0
33.0
30.0
32.0
32.0
32.0
34.0
34.0
36.0
35.0
36.0
37.0
37.0
34.0
32.0
31.0
30.0
32.0
32.0
32.0
34.0
34.0
34.0
35.0
35.0
35.0
36.0
36.0
36.0
37.0
36.0
36.0
36.0
34.0
36.0
35.0
33.0
32.0
31.0
30.0
30.0
29.0
30.0
29.0
30.0 Value from RAP6

CONDUCTIVITY VALUES FOR LINE:RA3D

Horizontal	
42.0	
42.0	
40.0	
38.0	
37.0	
35.0	
36.0	
34.0	
35.0	
33.0	
34.0	
33.0	
34.0	
36.0	
34.0	
37.0	
38.0	
36.0	
40.0	
37.0	
36.0	
36.0	
36.0	
38.0	
38.0	
35.0	
32.0	
36.0	
36.0	
36.0	
36.0	
33.0	
36.0	
35.0	
37.0	
36.0	
37.0	
40.0	
38.0	
36.0	
34.0	
31.0	
36.0	
36.0	Values
33.0	from
34.0	RAP6
32.0	
34.0	
32.0	
30.0	
33.0	
32.0	
34.0	
33.0	
32.0	
32.0	

CONDUCTIVITY VALUES FOR LINE:RA3E

Horizontal	
43.0	
42.0	
41.0	
39.0	
39.0	
38.0	
39.0	Values
38.0	from
37.0	RAP6
35.0	
37.0	
33.0	
34.0	
35.0	
35.0	
33.0	
32.0	
32.0	
35.0	
37.0	
38.0	
35.0	
34.0	
32.0	
33.0	
35.0	
34.0	
34.0	
40.0	
40.0	

CONDUCTIVITY VALUES FOR LINE:RA3F

Horizontal	
44.0	
44.0	
45.0	
40.0	
43.0	
49.0	
40.0	Values
38.0	from
37.0	RAP6
0.0	
0.0	SKIPPED
0.0	STATIONS
0.0	
34.0	
35.0	
35.0	
35.0	
37.0	Values
38.0	from
38.0	
34.0	RAP6
30.0	
33.0	
33.0	
34.0	
34.0	
32.0	
37.0	
39.0	
39.0	
38.0	
36.0	

CONDUCTIVITY VALUES FOR
LINE:RA3G

Horizontal
40.0
40.0
41.0
41.0
42.0
40.0
35.0

CONDUCTIVITY VALUES FOR
LINE:RA3H

Horizontal
38.0
40.0
40.0
36.0
40.0

CONDUCTIVITY VALUES FOR
LINE:RA3W

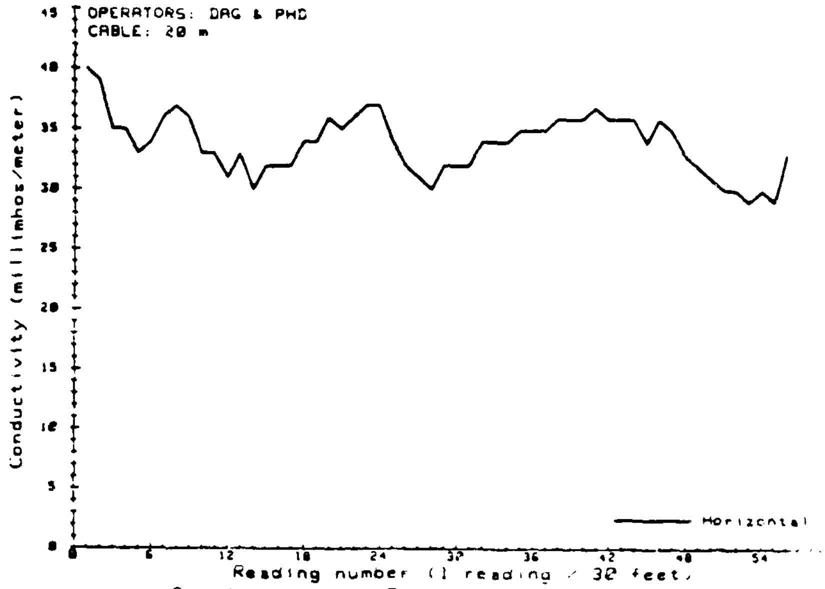
Horizontal
27.0
39.0
33.0
30.0
29.0
27.0
30.0

CONDUCTIVITY VALUES FOR
LINE:RA3X

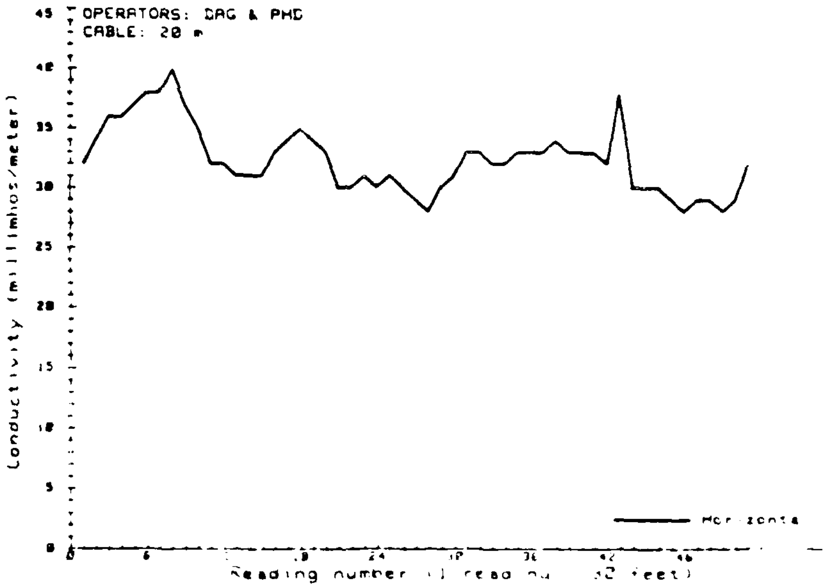
Horizontal
38.0
34.0
34.0
33.0
32.0
30.0
31.0
30.0

CONDUCTIVITY VALUES FOR
LINE:RA3Y

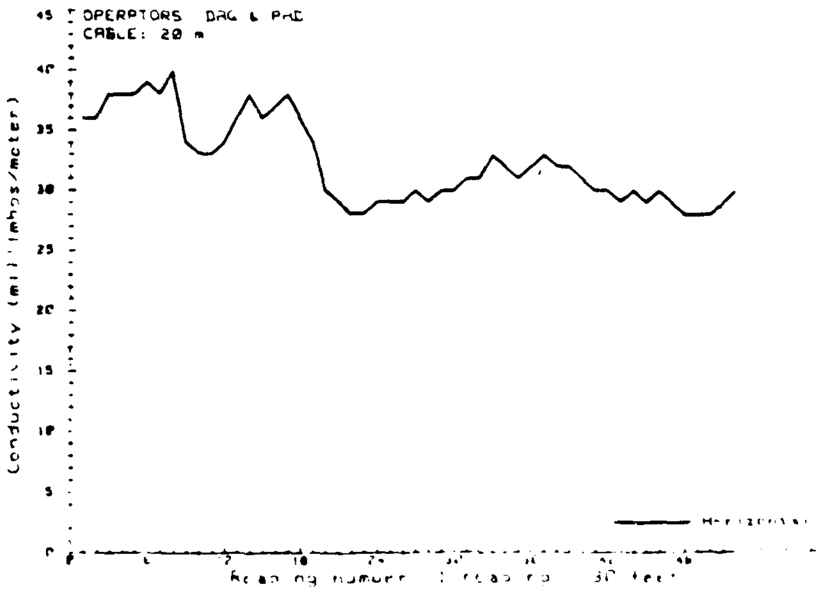
Horizontal
33.0
35.0
31.0
28.0
30.0
30.0
30.0
29.0
28.0



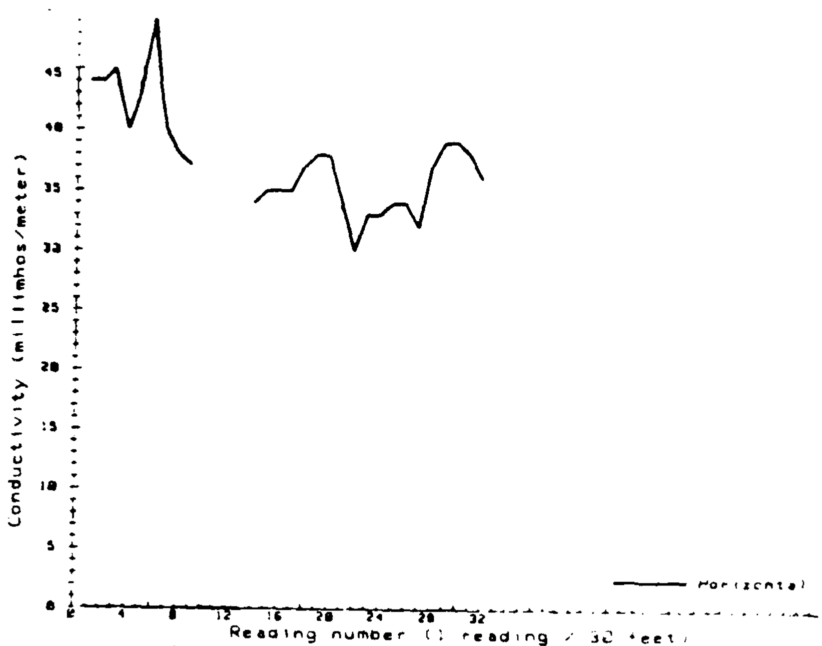
Conductivity Graph of Line: RA5C



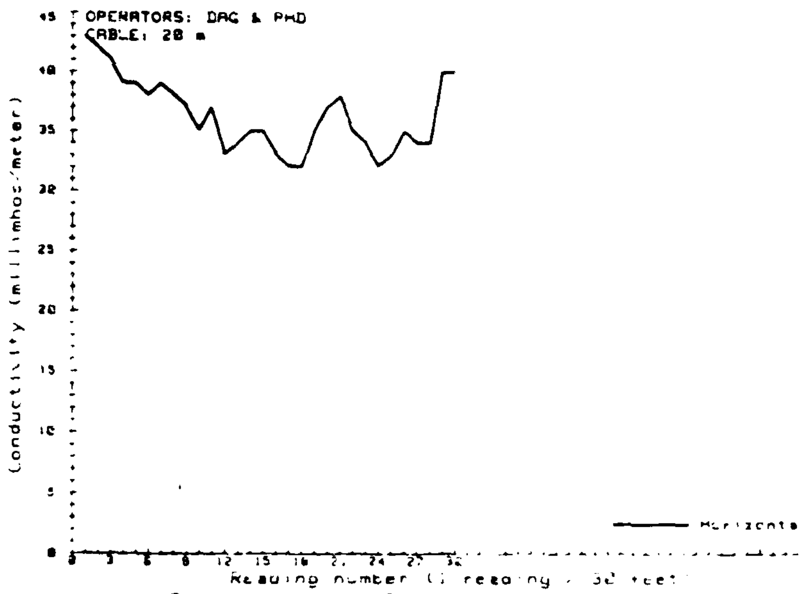
Conductivity Graph [illegible] RA5B



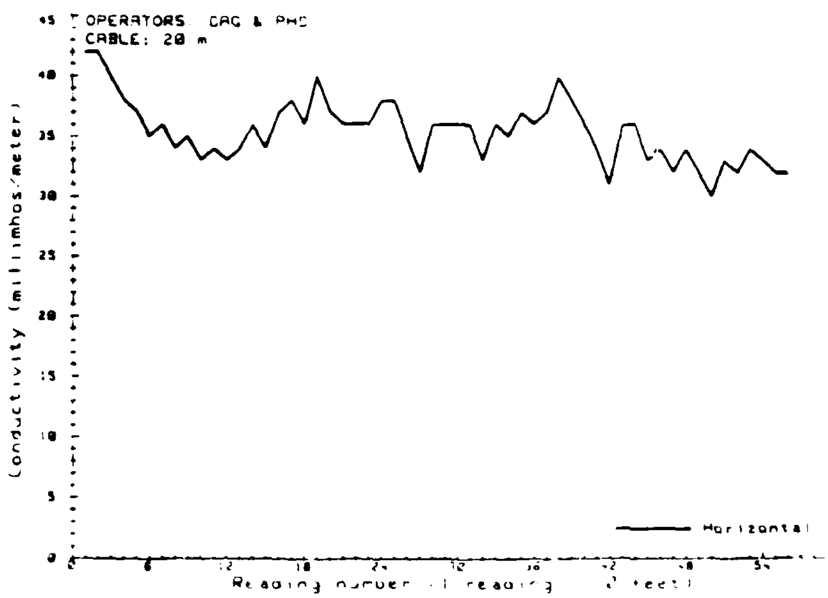
Conductivity Graph [illegible]

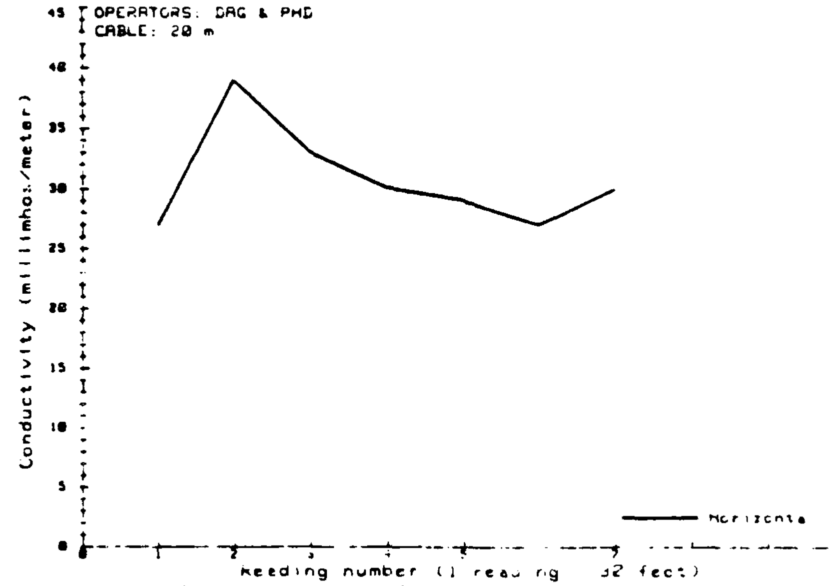


Conductivity Graph of Line:

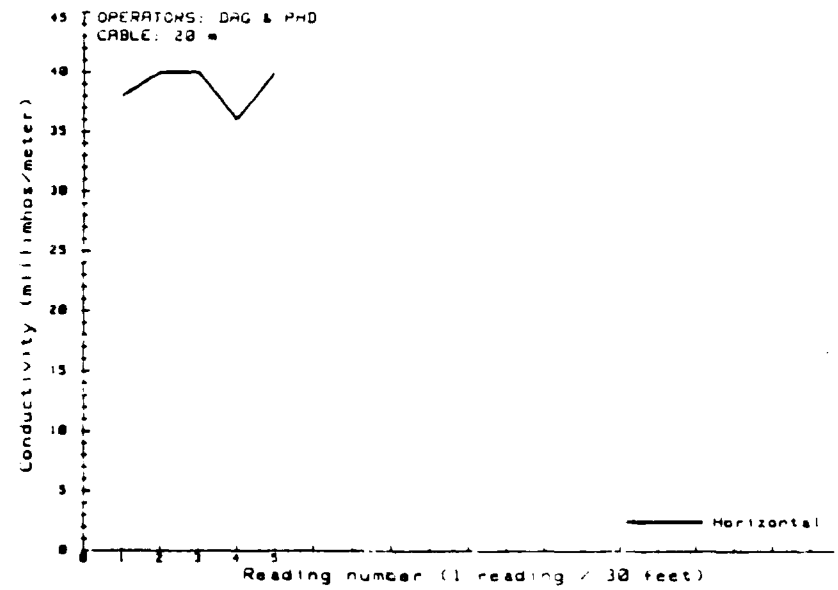


Conductivity Graph of Line:

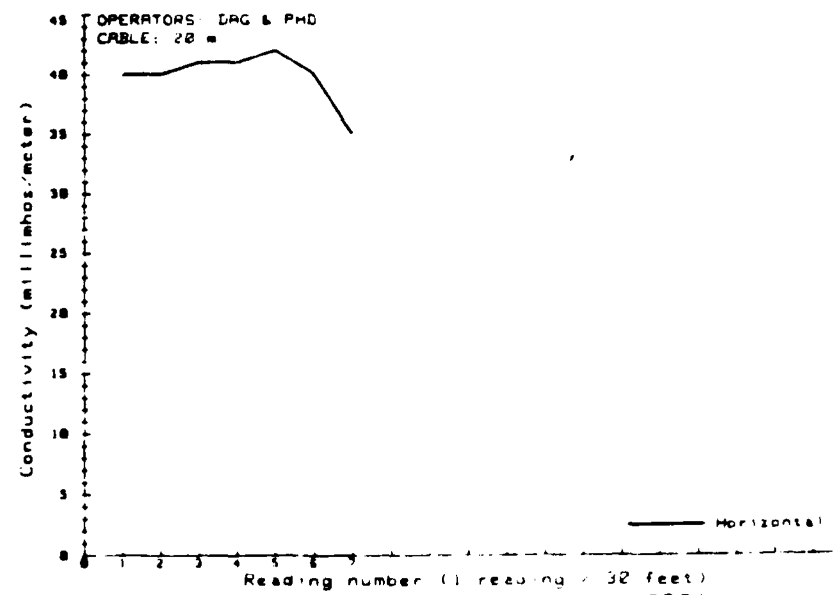




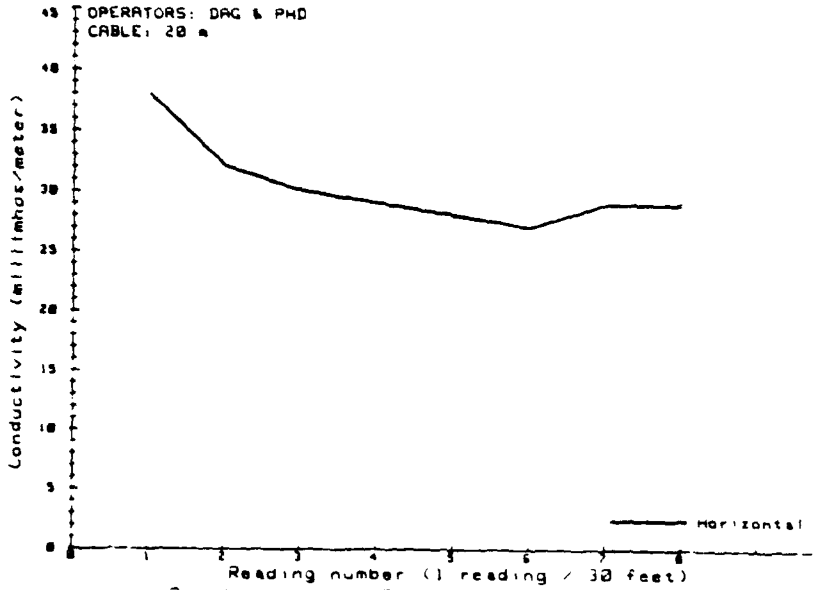
Conductivity Graph of Line: RA5W



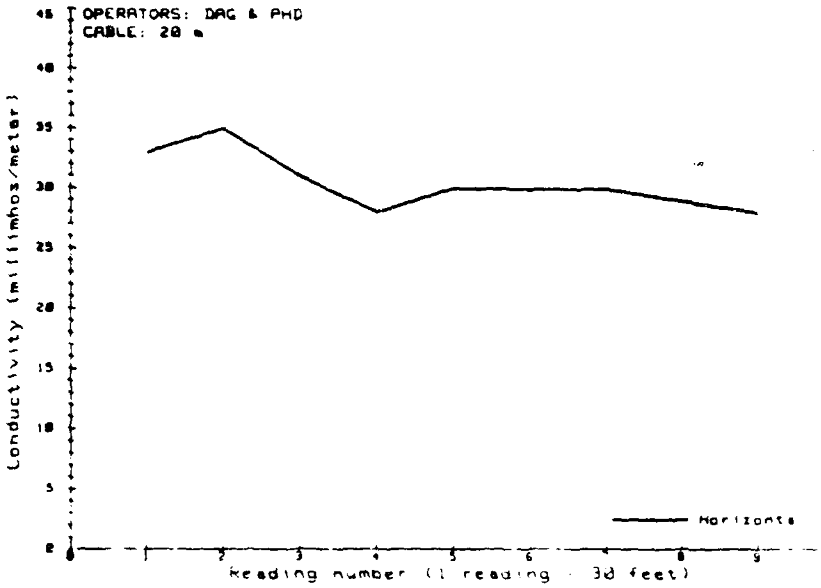
Conductivity Graph of Line: RA3H



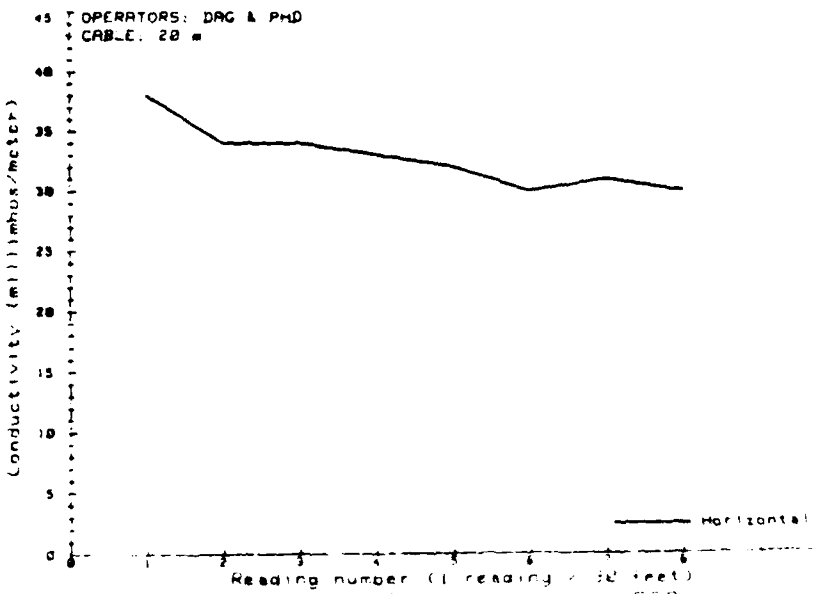
Conductivity Graph of Line: RA3S



Conductivity Graph of Line: RA3Z



Conductivity Graph of Line: RA3Y



Conductivity Graph of Line: RA3X

FDTA #2

CONDUCTIVITY VALUES FOR
LINE:RAFA

Horizontal
200.0
160.0
103.0
92.0
92.0
100.0
98.0
100.0
95.0
96.0
94.0
97.0
0.0 SKIP Pump House
0.0
82.0
65.0
63.0

CONDUCTIVITY VALUES FOR
LINE:RAFB

Horizontal
43.0
46.0
43.0
47.0
51.0
49.0
84.0
86.0
85.0
85.0
84.0
83.0
79.0
75.0
77.0
71.0
62.0
60.0
66.0
60.0
55.0
47.0

CONDUCTIVITY VALUES FOR
LINE:RAFC

Horizontal
47.0
43.0
42.0
44.0
49.0
54.0
58.0
57.0
60.0
73.0
83.0
81.0
79.0
80.0
79.0
77.0
71.0
67.0
63.0
56.0
56.0
54.0
53.0
50.0
47.0

CONDUCTIVITY VALUES FOR
LINE:RAFD

Horizontal
42.0
43.0
46.0
46.0
43.0
48.0
54.0
61.0
74.0
74.0
73.0
72.0
72.0
70.0
65.0
55.0
49.0
44.0
40.0
42.0
41.0
42.0
40.0
39.0

CONDUCTIVITY VALUES FOR
LINE:RAFE

Horizontal
44.0
45.0
44.0
43.0
48.0
53.0
66.0
66.0
70.0
77.0
76.0
75.0
71.0
62.0
54.0
46.0
45.0
41.0
37.0
34.0
37.0
36.0
34.0

CONDUCTIVITY VALUES FOR
LINE:RAFF

Horizontal
44.0
39.0
35.0
38.0
49.0
59.0
70.0
69.0
70.0
73.0
73.0
70.0
58.0
48.0
42.0
40.0
40.0
58.0
42.0
52.0
36.0
32.0
33.0

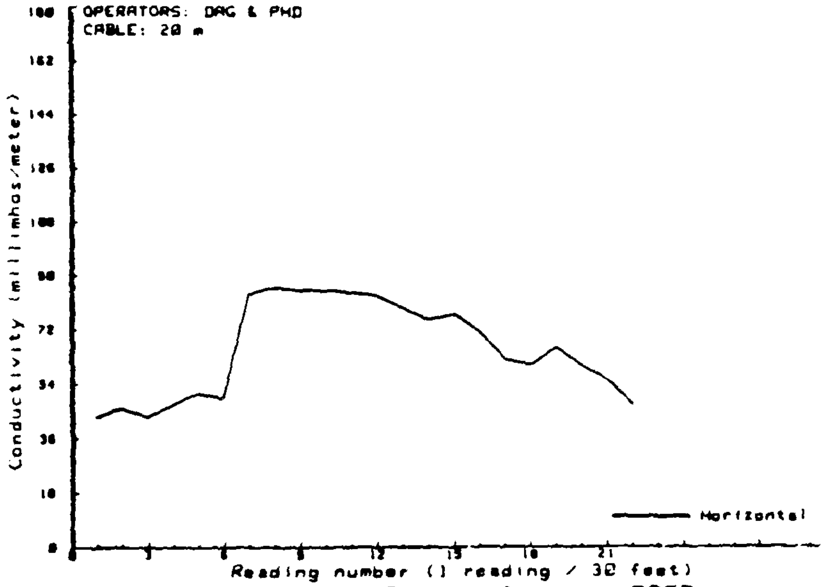
CONDUCTIVITY VALUES FOR
LINE:RAFG

Horizontal
41.0
40.0
39.0
43.0
49.0
59.0
60.0
66.0
57.0
60.0
65.0
67.0
69.0
68.0
62.0
55.0
59.0
52.0
51.0
41.0
41.0
37.0
32.0
32.0
31.0
33.0
34.0

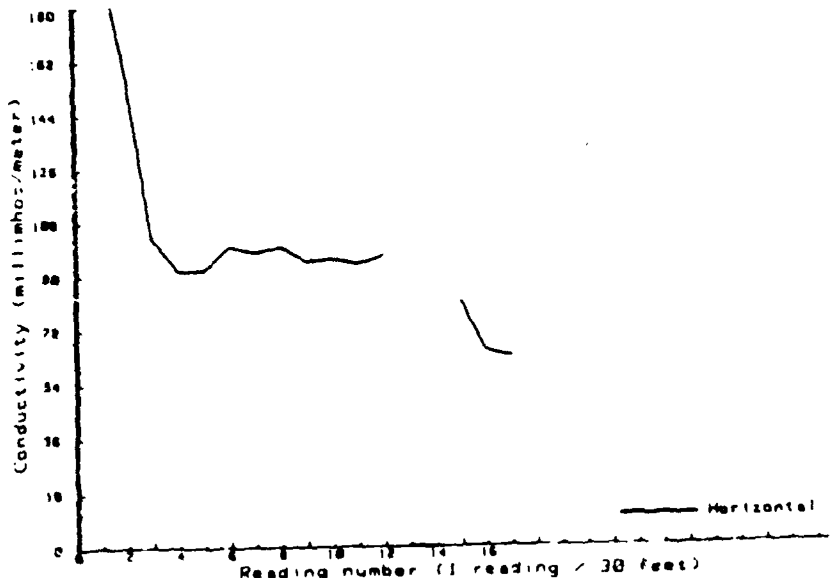
CONDUCTIVITY VALUES FOR
LINE:RAFH

Horizontal
40.0
34.0
38.0
46.0
58.0
50.0
48.0
46.0
47.0
52.0
51.0
50.0
54.0
55.0
56.0
47.0
49.0
39.0

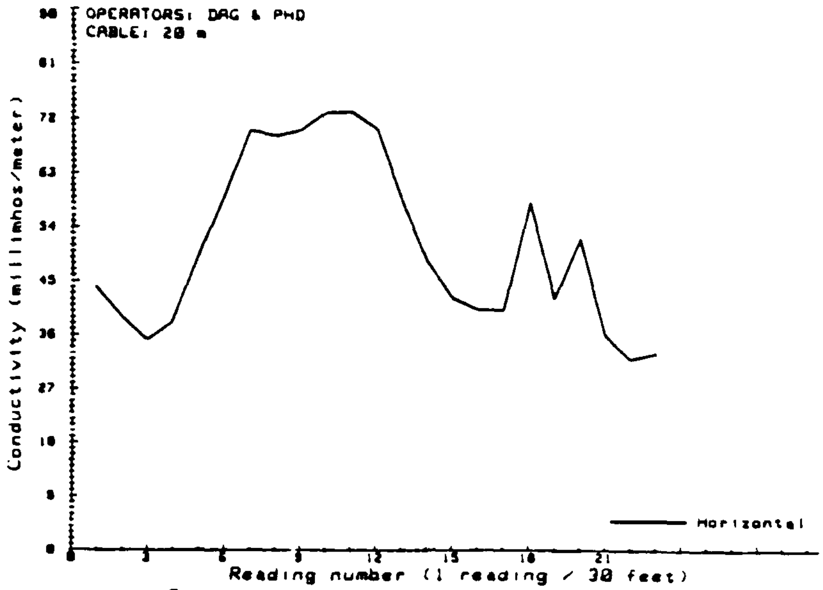
Conductivity Graph of Line: RAFC



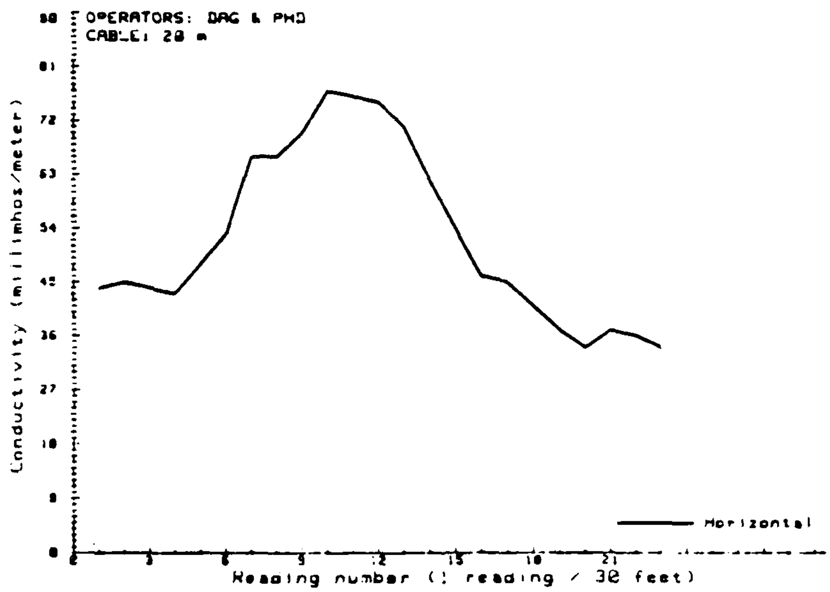
Conductivity Graph of Line: RAFB



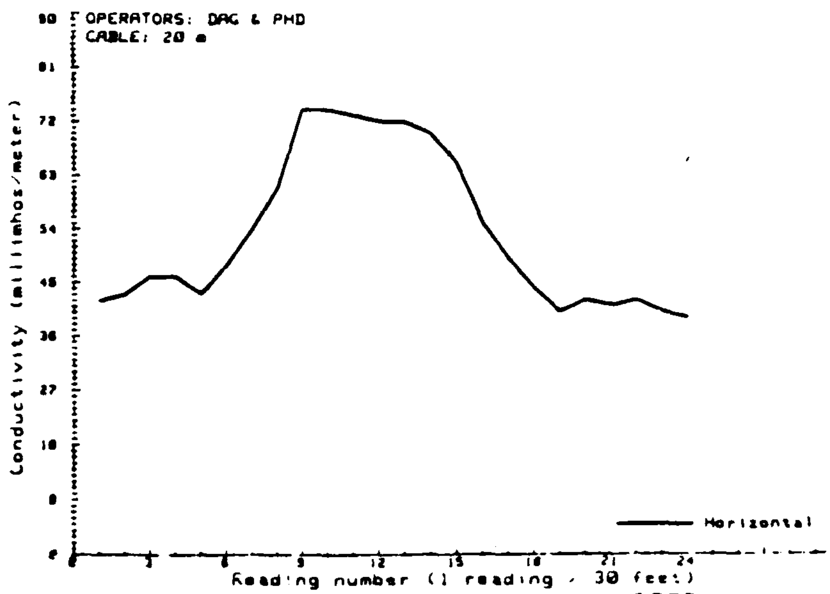
Conductivity Graph of Line: RAFA



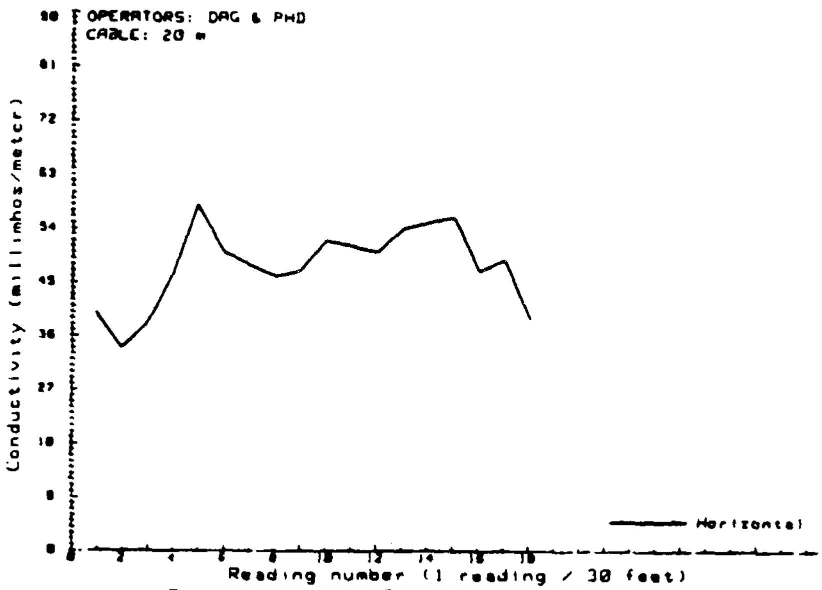
Conductivity Graph of Line: RAFF



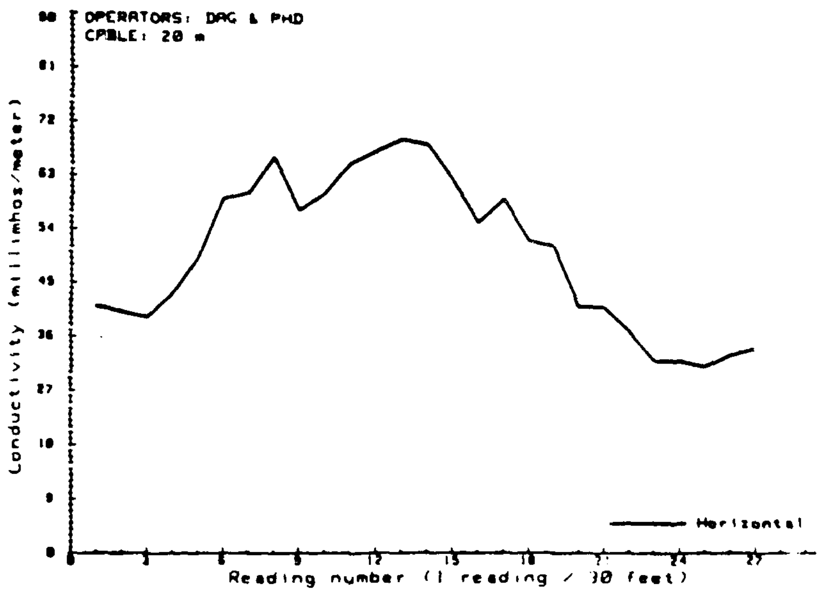
Conductivity Graph of Line: RAFE



Conductivity Graph of Line: RAFD



Conductivity Graph of Line: RAFH



Conductivity Graph of Line: RAFG

PERIMETER LINES

CONDUCTIVITY VALUES FOR LINE:RAP1

Vertical	Horizontal
0.0	0.0
105.0	60.0
36.0	61.0
2.0	52.0
54.0	54.0
46.0	52.0
39.0	51.0
33.0	49.0
33.0	51.0
34.0	51.0
43.0	50.0
29.0	50.0
32.0	50.0
28.0	50.0
24.0	51.0
31.0	48.0
33.0	47.0
32.0	44.0
34.0	44.0
42.0	43.0
49.0	41.0
125.0	39.0
0.0	47.0
0.0	50.0
10.0	45.0
15.0	28.0
20.0	26.0
68.0	40.0
43.0	35.0
35.0	34.0
41.0	33.0
44.0	35.0
35.0	35.0
34.0	37.0
37.0	39.0
34.0	39.0
30.0	42.0
36.0	40.0
36.0	42.0
28.0	42.0
33.0	42.0
38.0	43.0

CONDUCTIVITY VALUES FOR LINE:RAP2

Vertical	Horizont
34.0	57.0
38.0	58.0
36.0	56.0
34.0	52.0
40.0	49.0
57.0	48.0
36.0	44.0
8.0	48.0
84.0	42.0
42.0	49.0
31.0	50.0
26.0	49.0
28.0	49.0
43.0	47.0
32.0	45.0
28.0	44.0
28.0	45.0
34.0	47.0
38.0	48.0
33.0	45.0
26.0	42.0
30.0	40.0
30.0	38.0
40.0	38.0
44.0	38.0
88.0	44.0
40.0	26.0
100.0	26.0
58.0	49.0
45.0	46.0
41.0	43.0
39.0	44.0
61.0	41.0
37.0	41.0
46.0	39.0
0.0	22.0
75.0	41.0
52.0	41.0
26.0	39.0
50.0	45.0

CONDUCTIVITY VALUES FOR LINE:RAP3

Vertical	Horizontal
210.0	50.0
210.0	70.0
230.0	101.0
20.0	84.0
210.0	96.0
165.0	98.0
170.0	94.0
150.0	90.0
104.0	82.0
135.0	92.0
103.0	93.0
102.0	90.0
125.0	90.0
104.0	96.0
105.0	96.0
145.0	99.0
106.0	109.0
106.0	105.0
104.0	62.0
115.0	57.0
102.0	65.0
105.0	92.0
104.0	96.0
102.0	103.0
103.0	99.0
94.0	92.0
90.0	85.0
90.0	80.0
89.0	76.0
99.0	72.0
102.0	71.0
79.0	72.0
66.0	70.0
51.0	72.0
60.0	73.0
37.0	72.0
57.0	66.0
57.0	68.0
54.0	70.0
52.0	72.0
48.0	76.0
30.0	68.0
20.0	66.0
42.0	64.0
46.0	60.0
37.0	52.0
33.0	51.0
34.0	50.0
33.0	49.0
35.0	44.0
29.0	42.0
32.0	40.0
33.0	40.0
36.0	38.0
37.0	34.0
34.0	36.0
21.0	39.0
20.0	43.0

CONDUCTIVITY VALUES FOR LINE:RAP3B

Vertical	Horizontal
29.0	42.0
29.0	43.0
26.0	41.0
29.0	38.0
43.0	31.0
45.0	32.0
41.0	43.0
38.0	32.0
41.0	33.0
39.0	32.0
38.0	32.0
50.0	31.0
44.0	32.0
40.0	33.0
36.0	30.0
39.0	29.0
43.0	31.0
42.0	33.0
45.0	35.0
44.0	35.0
38.0	38.0
37.0	38.0
39.0	42.0
34.0	41.0
40.0	36.0
48.0	34.0
50.0	35.0
46.0	35.0
47.0	34.0
47.0	36.0
45.0	35.0
47.0	32.0
63.0	43.0
62.0	29.0
49.0	28.0
40.0	26.0
36.0	25.0
35.0	28.0
32.0	30.0
35.0	30.0
33.0	29.0
34.0	32.0
36.0	33.0
40.0	34.0
39.0	34.0
38.0	32.0
43.0	33.0
43.0	31.0
40.0	31.0
32.0	32.0
31.0	31.0
35.0	31.0
38.0	31.0
34.0	30.0
30.0	30.0
30.0	32.0
30.0	32.0
33.0	32.0
31.0	31.0
30.0	32.0
35.0	31.0
30.0	33.0

CONDUCTIVITY VALUES FOR LINE:RAP4

Vertical	Horizonta
70.0	58.0
64.0	58.0
60.0	58.0
59.0	59.0
63.0	61.0
53.0	61.0
60.0	64.0
57.0	68.0
54.0	72.0
51.0	70.0
60.0	71.0
59.0	72.0
49.0	72.0
56.0	70.0
57.0	73.0
48.0	75.0
53.0	73.0
50.0	73.0
49.0	72.0
59.0	70.0
60.0	69.0
45.0	68.0
44.0	68.0
43.0	68.0
43.0	66.0
66.0	64.0
55.0	61.0
54.0	60.0
53.0	61.0
61.0	61.0
50.0	64.0
46.0	68.0
46.0	69.0
41.0	70.0
40.0	66.0
38.0	64.0
49.0	60.0
46.0	62.0
37.0	60.0
33.0	55.0
41.0	53.0
53.0	52.0
49.0	55.0
36.0	56.0
34.0	52.0
40.0	50.0
32.0	44.0
35.0	47.0
38.0	46.0
29.0	49.0
29.0	46.0
30.0	47.0
46.0	36.0
28.0	25.0
26.0	39.0
43.0	34.0
32.0	33.0
29.0	31.0

CONDUCTIVITY VALUES FOR LINE:RH4B

Vertical	Horizontal
32.0	36.0
35.0	38.0
31.0	37.0
25.0	40.0
33.0	40.0
32.0	41.0
26.0	41.0
28.0	41.0
28.0	42.0
30.0	42.0
30.0	41.0
26.0	37.0
34.0	33.0
42.0	31.0
36.0	30.0
38.0	31.0
38.0	32.0
32.0	33.0
32.0	34.0
37.0	35.0
31.0	35.0
27.0	36.0
28.0	38.0
28.0	39.0
31.0	40.0
29.0	41.0
28.0	41.0
36.0	38.0
30.0	36.0
34.0	34.0
32.0	36.0
29.0	35.0
30.0	34.0
34.0	35.0
33.0	34.0
29.0	36.0
29.0	36.0
33.0	35.0
30.0	34.0
28.0	34.0
25.0	34.0
30.0	36.0
32.0	34.0
30.0	34.0
30.0	35.0
30.0	34.0
32.0	36.0
34.0	36.0
33.0	36.0
34.0	34.0
36.0	34.0
32.0	33.0
33.0	34.0
37.0	34.0
26.0	34.0
34.0	34.0
28.0	33.0
34.0	32.0

CONDUCTIVITY VALUES FOR LINE:RAP4C

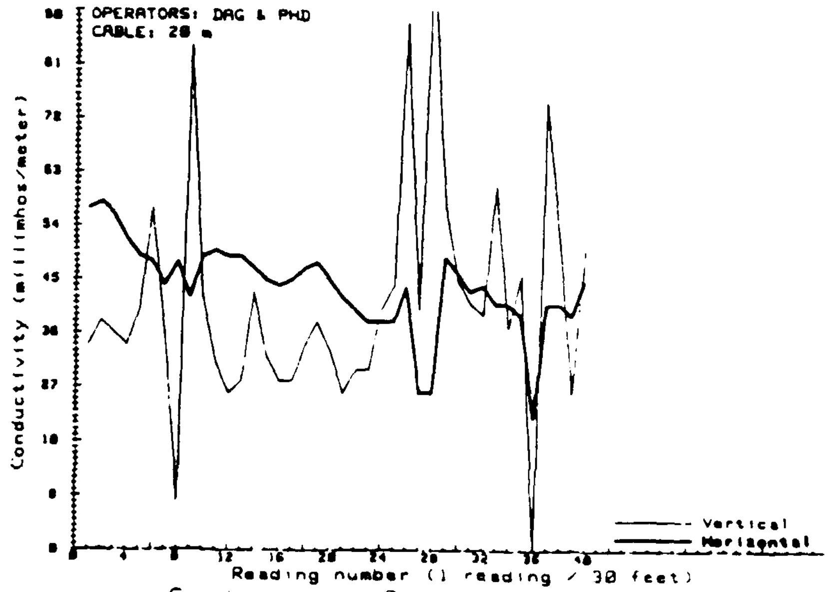
Vertical	Horizontal
31.0	32.0
33.0	30.0
29.0	29.0
33.0	30.0
30.0	32.0
34.0	33.0
30.0	35.0
30.0	31.0
28.0	31.0
28.0	30.0
28.0	32.0
26.0	32.0
28.0	33.0

CONDUCTIVITY VALUES FOR LINE:RAF5

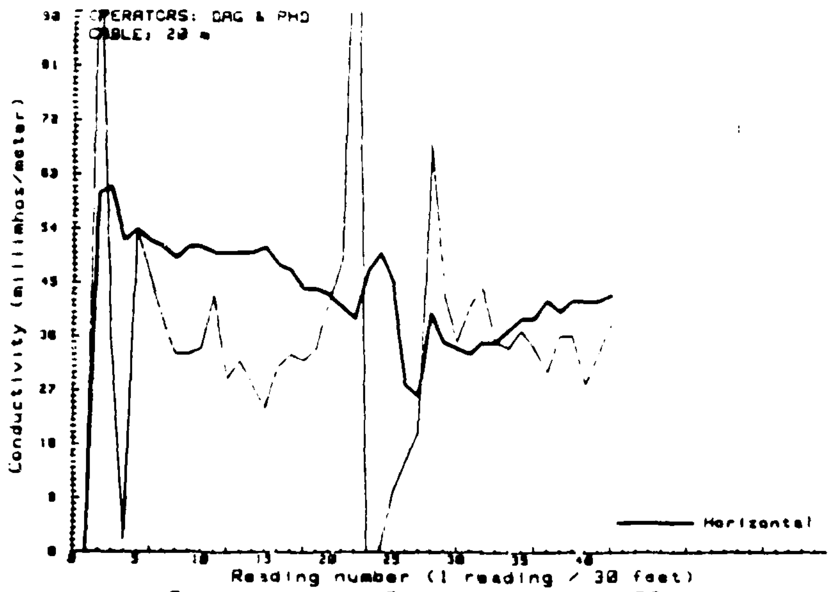
Vertical	Horizontal
300.0	250.0
300.0	105.0
160.0	68.0
76.0	66.0
47.0	66.0
44.0	64.0
35.0	66.0
26.0	62.0
17.0	52.0
32.0	40.0
48.0	37.0
34.0	36.0
25.0	36.0
25.0	37.0
30.0	36.0
36.0	37.0
32.0	35.0
41.0	33.0
41.0	34.0
36.0	35.0
36.0	37.0
36.0	38.0
34.0	37.0
39.0	37.0
34.0	37.0
33.0	35.0
38.0	36.0
39.0	42.0
41.0	41.0
44.0	47.0
52.0	47.0
30.0	40.0
29.0	38.0
38.0	38.0
39.0	38.0
38.0	38.0
38.0	38.0
42.0	36.0
42.0	36.0
39.0	36.0
35.0	36.0
45.0	37.0
42.0	36.0
40.0	36.0
40.0	36.0
48.0	37.0
44.0	36.0
36.0	35.0
44.0	36.0
51.0	36.0
48.0	34.0

CONDUCTIVITY VALUES FOR LINE:RAP6

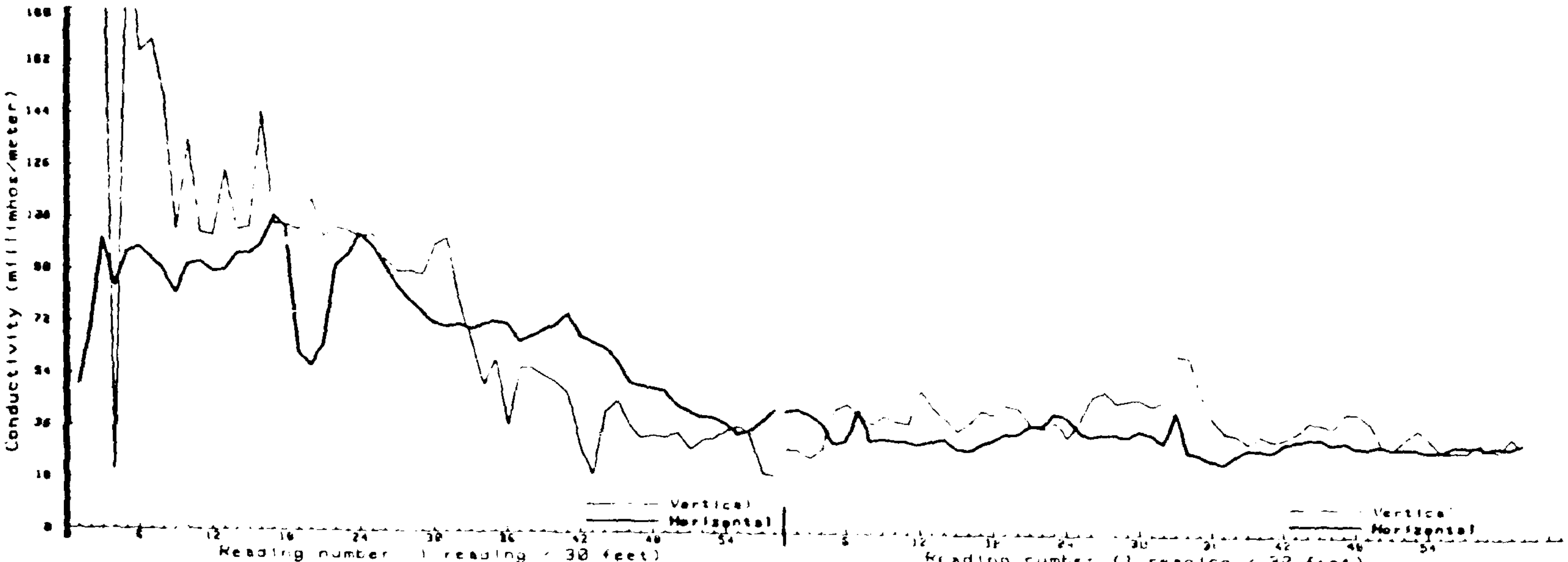
Vertical	Horizontal	Vertical	Horizontal
19.0	3.0	26.0	33.0
44.0	100.0	29.0	36.0
58.0	56.0	31.0	37.0
56.0	38.0	30.0	36.0
43.0	32.0	30.0	35.0
33.0	30.0	32.0	35.0
32.0	29.0	34.0	35.0
34.0	28.0	32.0	36.0
33.0	27.0	32.0	35.0
28.0	29.0	32.0	34.0
29.0	26.0	30.0	31.0
23.0	28.0	29.0	36.0
20.0	30.0	29.0	36.0
1.0	30.0	32.0	33.0
1.0	33.0	28.0	34.0
30.0	34.0	29.0	32.0
26.0	40.0	28.0	34.0
26.0	36.0	30.0	32.0
27.0	40.0	28.0	30.0
30.0	38.0	25.0	33.0
29.0	38.0	26.0	32.0
30.0	37.0	25.0	34.0
26.0	39.0	28.0	33.0
25.0	38.0	23.0	32.0
29.0	37.0	22.0	32.0
31.0	35.0	27.0	33.0
29.0	34.0	28.0	34.0
34.0	35.0	22.0	33.0
30.0	35.0	25.0	32.0
25.0	35.0	24.0	28.0
28.0	37.0	28.0	35.0
30.0	38.0	25.0	36.0
30.0	38.0	27.0	34.0
32.0	34.0	25.0	34.0
28.0	30.0	23.0	36.0
25.0	33.0	26.0	33.0
28.0	33.0	26.0	33.0
26.0	34.0	32.0	32.0
30.0	34.0	30.0	34.0
33.0	32.0		
25.0	37.0		
28.0	39.0		
35.0	39.0		
27.0	38.0		
25.0	36.0		
16.0	40.0		
23.0	40.0		
29.0	36.0		
25.0	36.0		
23.0	36.0		
28.0	36.0		



Conductivity Graph of Line: RAP2

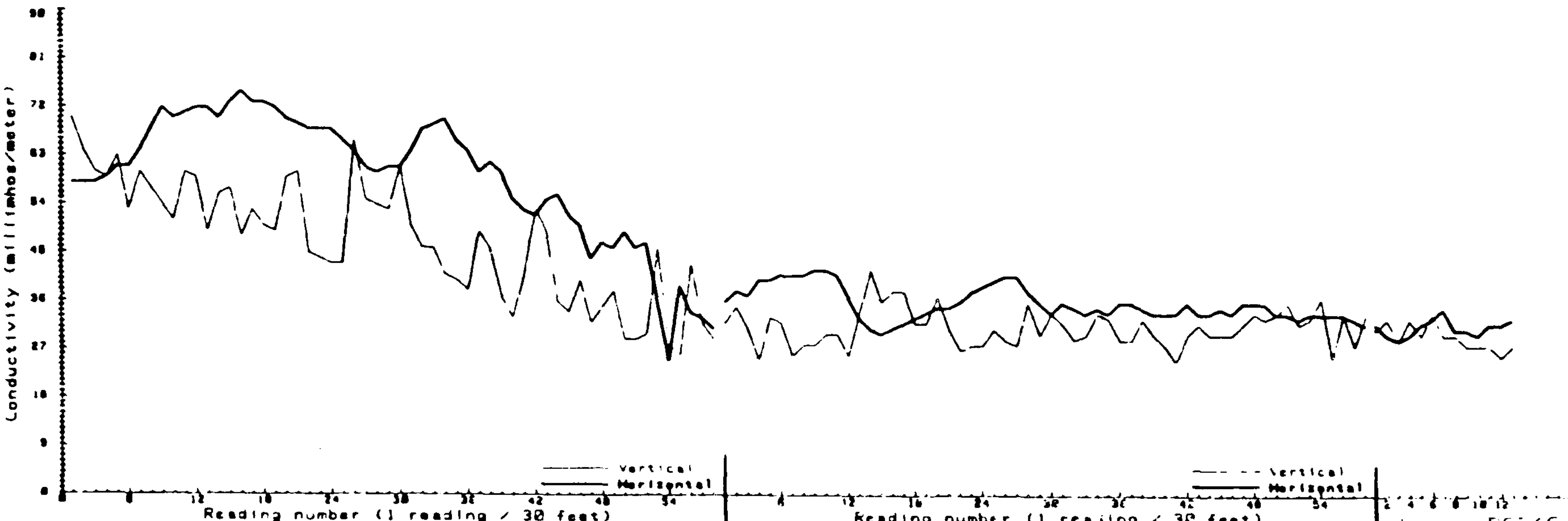


Conductivity Graph of Line: RAP1



Conductivity Graph of Line: RAP3

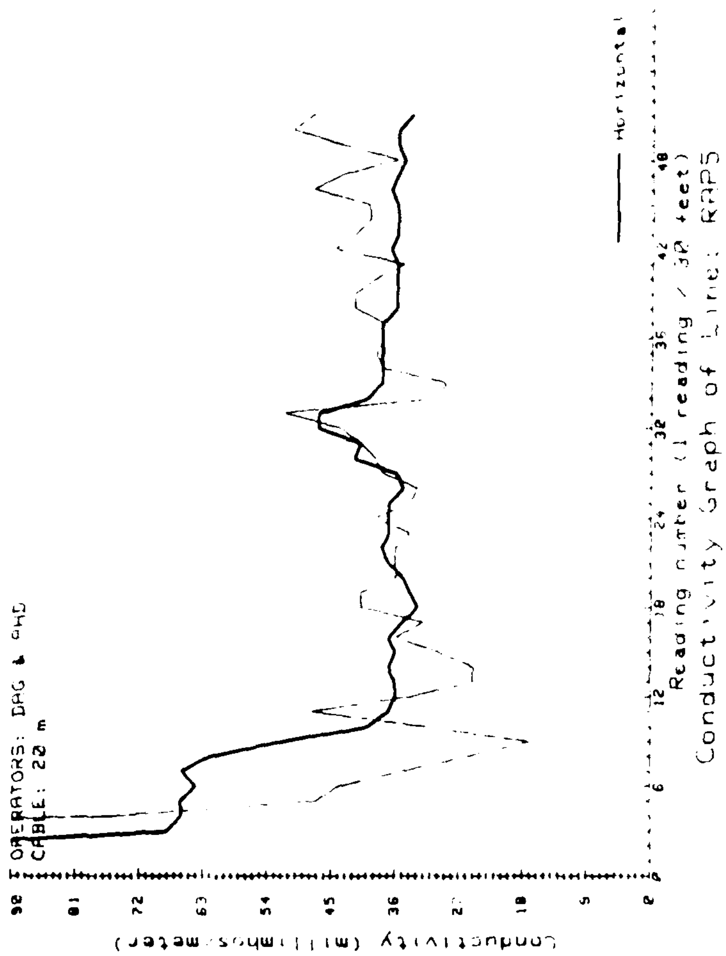
Conductivity Graph of Line: RAP3P

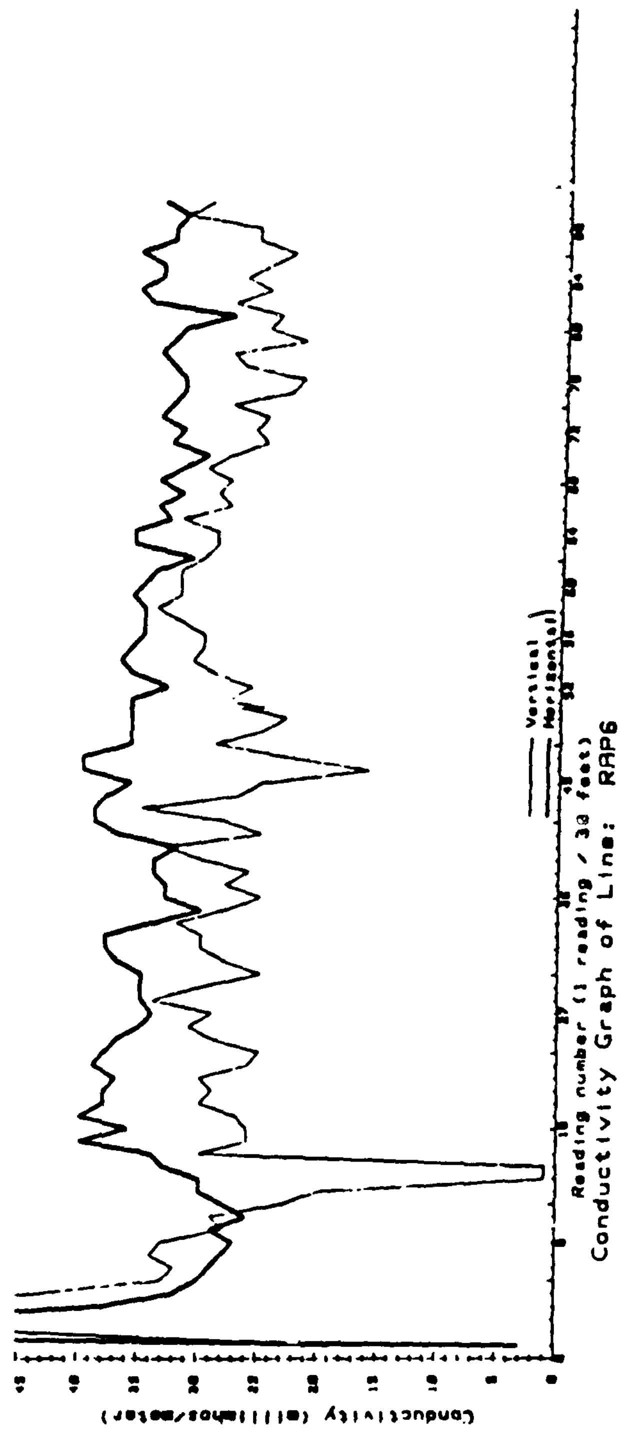


Conductivity Graph of Line: RAP4

Conductivity Graph of Line: RA4B

Line: RFF4C


OPERATORS: DAG & PHD
CABLE: 20 m
Horizontal
Conductivity (millimhos/meter)
90
81
72
63
54
45
36
27
18
9
0
6
12
18
24
30
36
42
48
Reading number (1 reading / 30 feet)
Conductivity Graph of Line: RRP5


Conductivity Graph of Line: RAP6
Reading number (1 reading / 30 feet)
Vertical
Horizontal
Conductivity (millimhos/meter)

LINES 4A, S1, S

ONDUCTIVITY VALUES FOR
LINE:RA4A

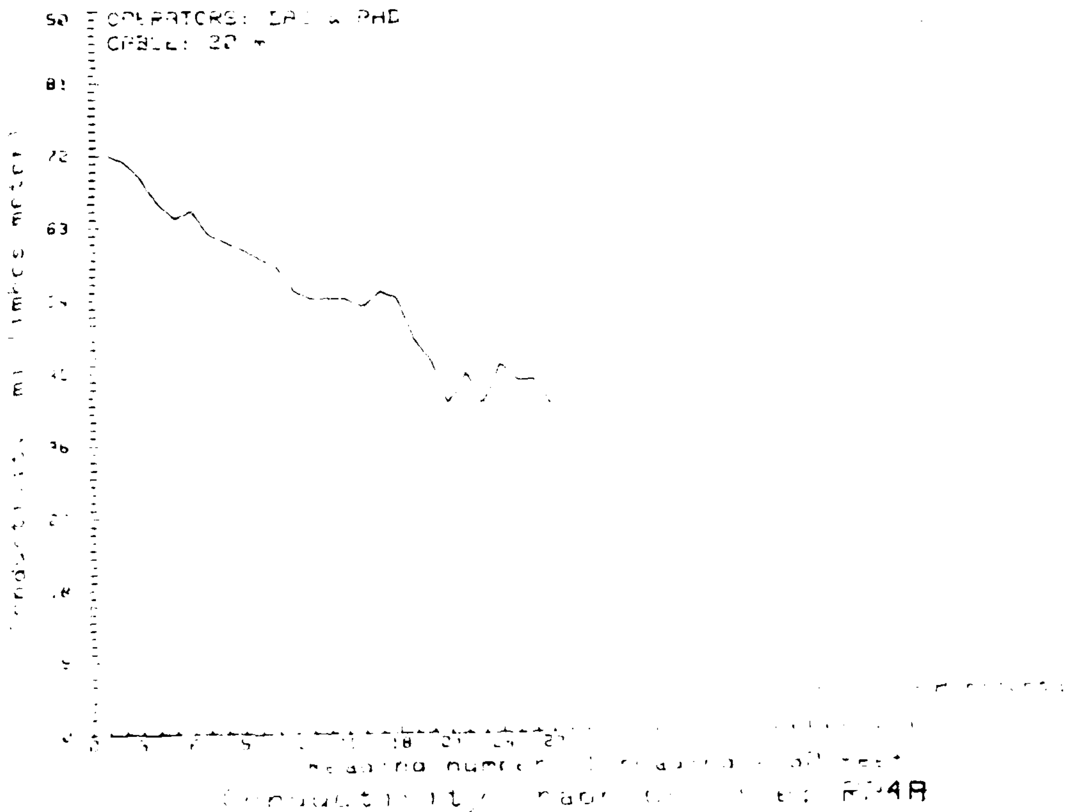
Horizontal
72.0
71.0
69.0
66.0
64.0
65.0
62.0
61.0
60.0
59.0
58.0
55.0
54.0
54.0
54.0
53.0
55.0
54.0
49.0
46.0
41.0
45.0
41.0
46.0
44.0
44.0
41.0

ONDUCTIVITY VAL[illegible]ES FOR
LINE:RAS1

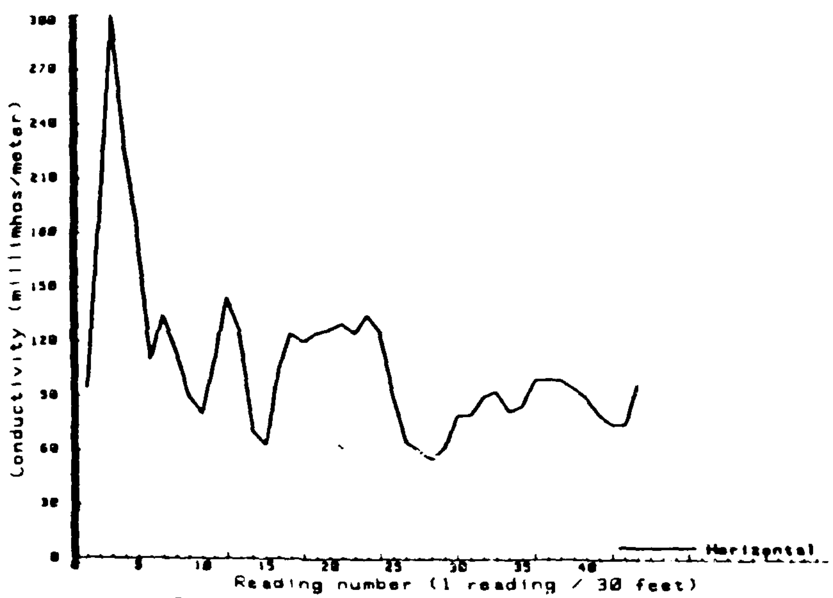
Horizontal
95.0
190.0
300.0
225.0
180.0
110.0
135.0
115.0
90.0
80.0
110.0
145.0
125.0
70.0
63.0
105.0
125.0
120.0
125.0
127.0
130.0
125.0
135.0
125.0
90.0
65.0
60.0
55.0
62.0
80.0
80.0
90.0
93.0
82.0
85.0
100.0
100.0
100.0
95.0
90.0
80.0
75.0
75.0
98.0

CONDUCTIVITY VALUES FOR
LINE:RAS

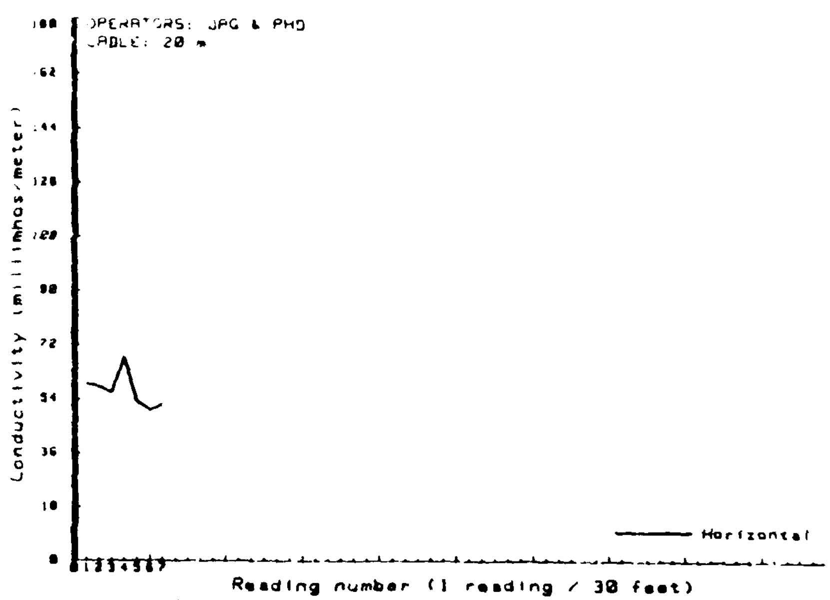
Horizontal
59.0
58.0
56.0
68.0
53.0
50.0
52.0



72
63

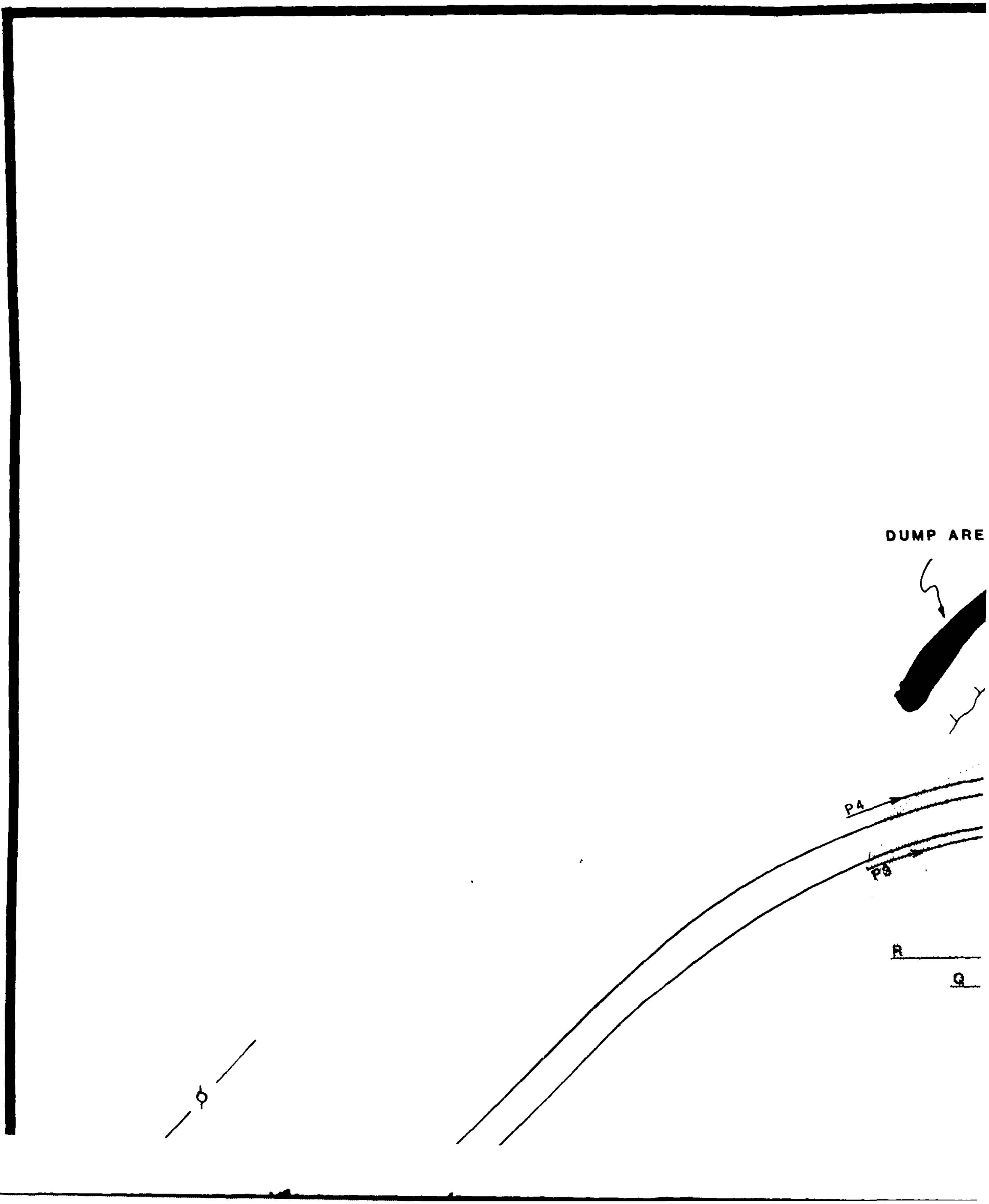


Conductivity Graph of Line: RASI

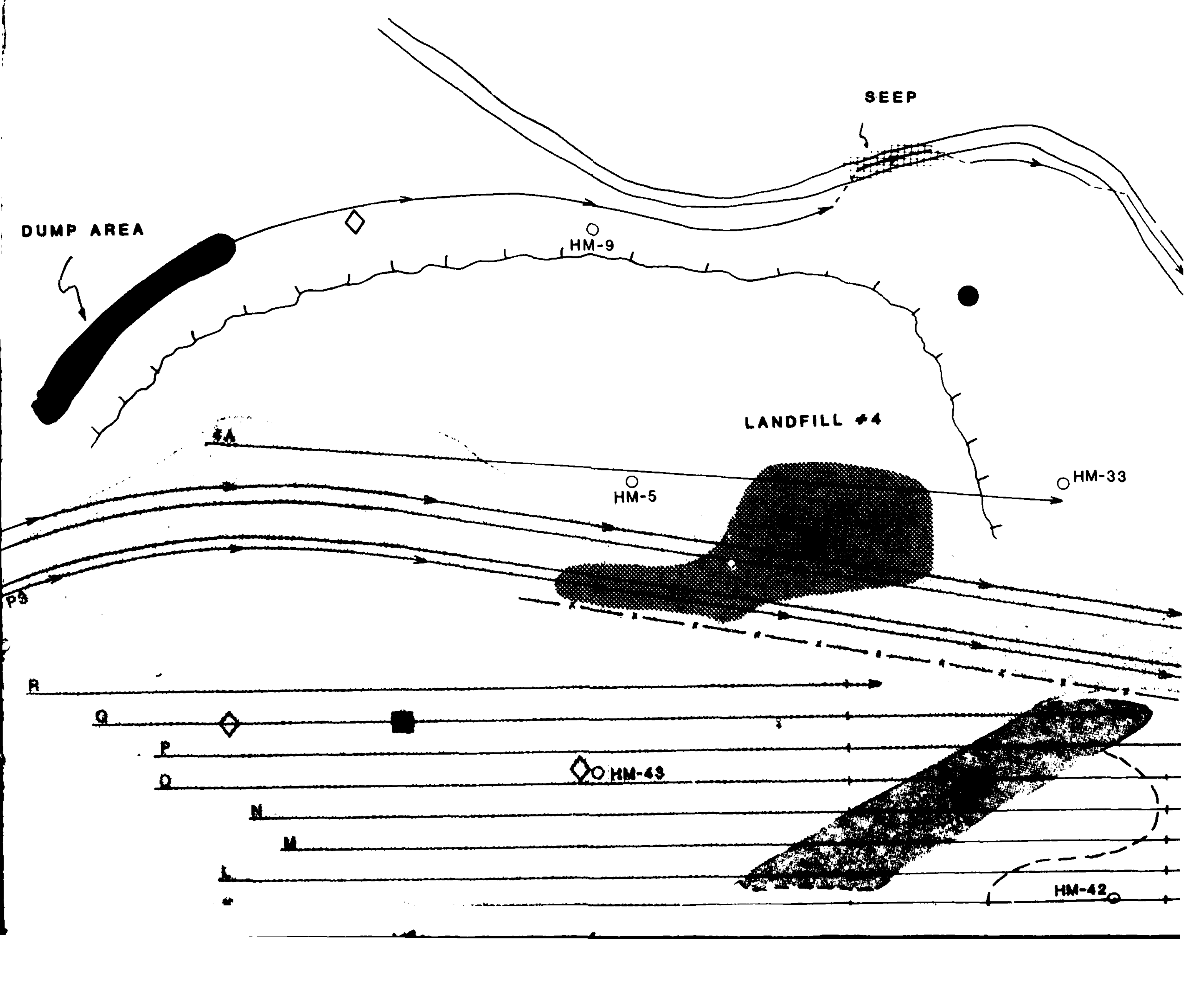


Conductivity Graph of Line: RAS

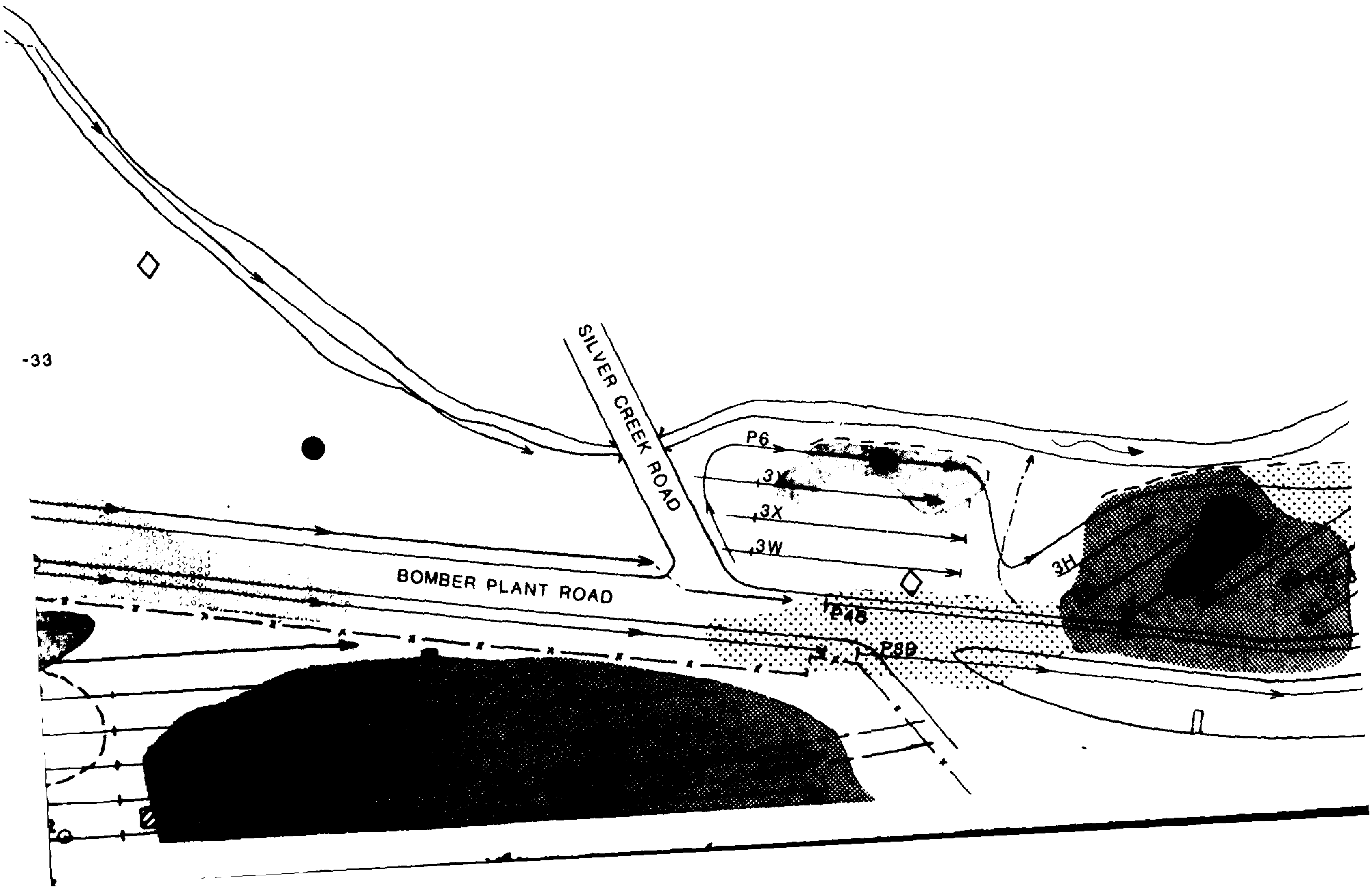
CONDUCTIVITY SURVEY MAP

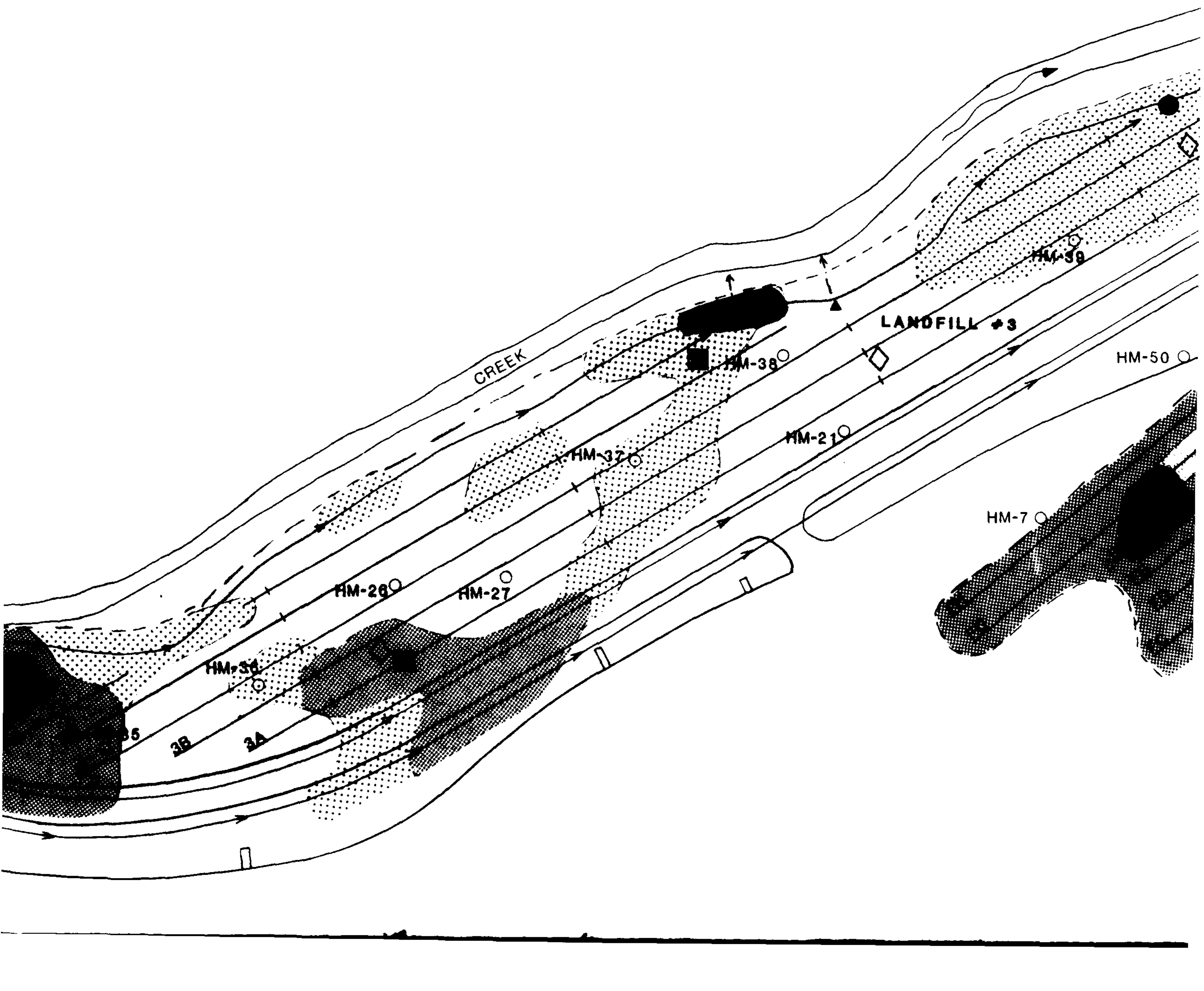


DUMP ARE
P4
P3
R
Q

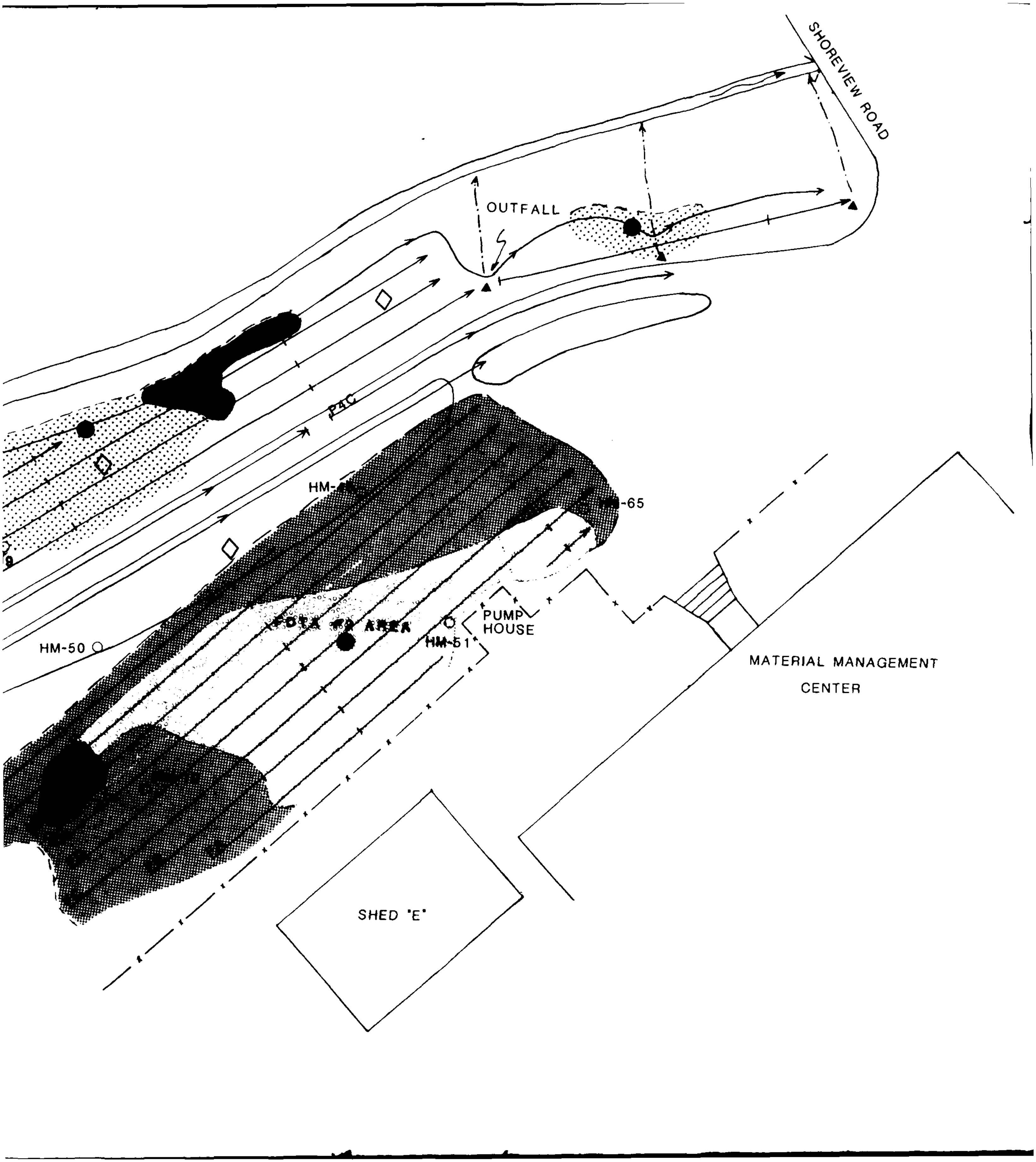


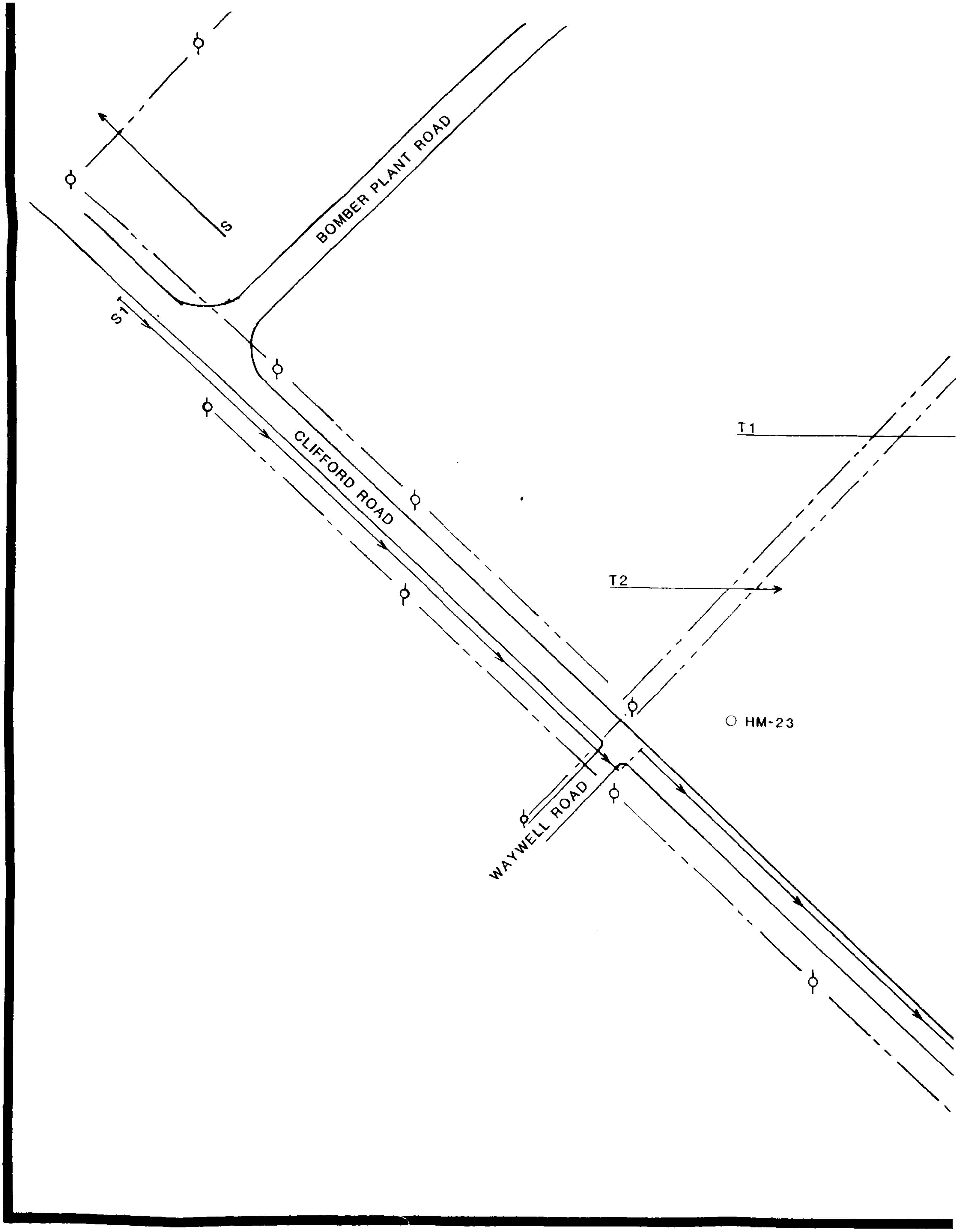
SEEP
DUMP AREA
HM-9
LANDFILL #4
4A
HM-5
HM-33
PS
R
Q
P
O
HM-43
N
M
L
HM-42


-33
SILVER CREEK ROAD
BOMBER PLANT ROAD
P6
3Y
3X
3W
3H

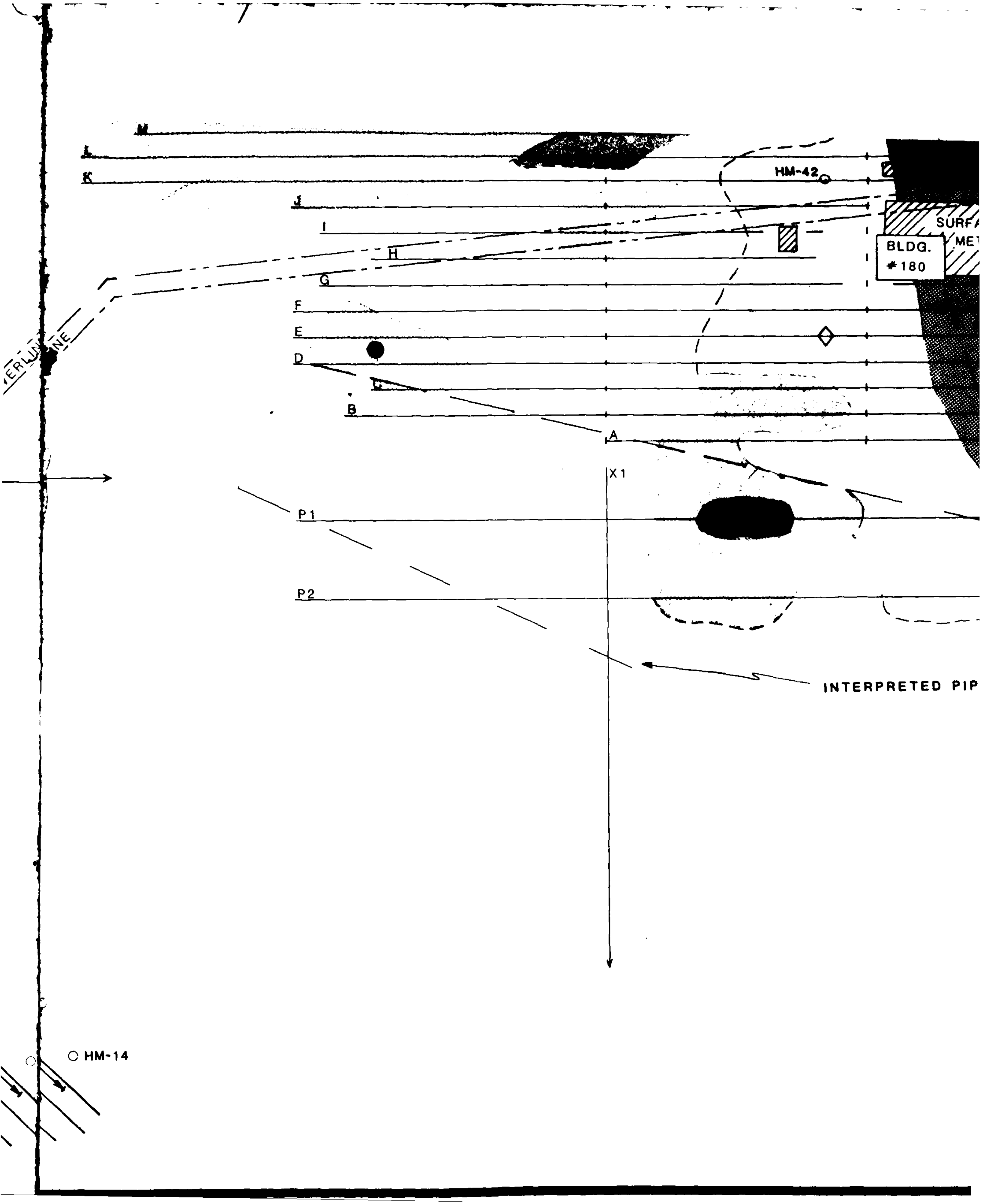


CREEK
LANDFILL #3
HM-38
HM-39
HM-50
HM-21
HM-37
HM-7
HM-26
HM-27
3B
3A

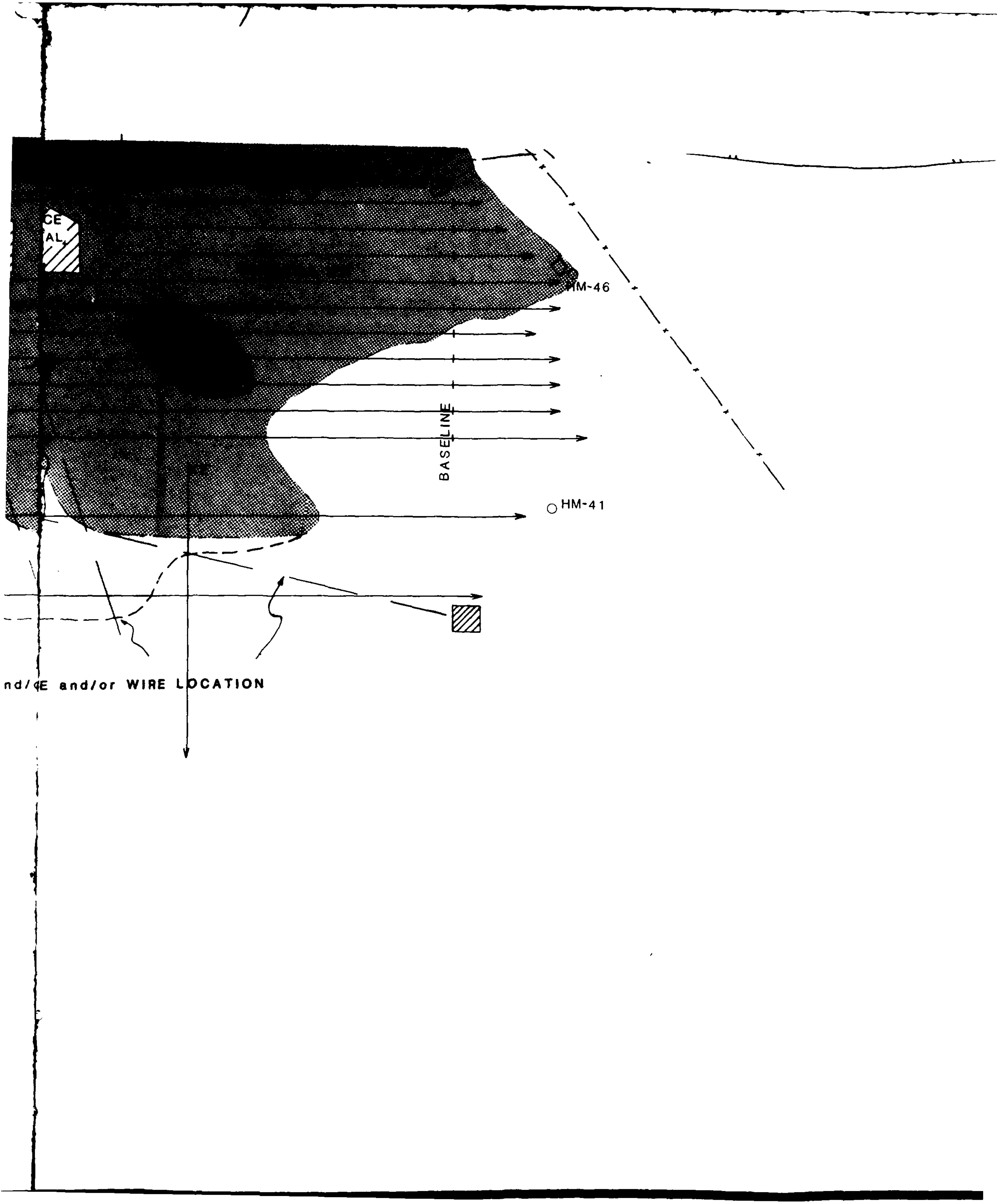

SHOREVIEW ROAD
OUTFALL
P4C
HM-50
HM-51
PUMP
HOUSE
MATERIAL MANAGEMENT
CENTER
SHED "E"



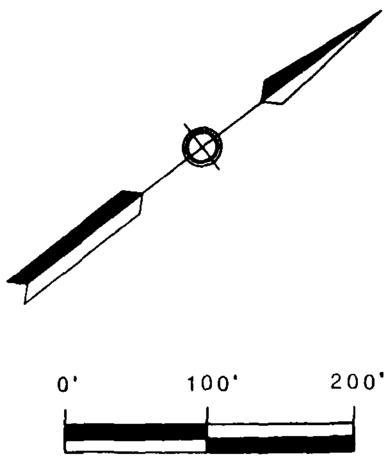
BOMBER PLANT ROAD
S
S1
CLIFFORD ROAD
T1
T2
HM-23
WAYWELL ROAD



HM-42
SURF
MET
BLDG.
#180
A
B
C
D
E
F
G
H
I
J
K
L
M
X1
P1
P2
INTERPRETED PIP
HM-14



CE
AL
HM-46
BASELINE
HM-41
nd/CE and/or WIRE LOCATION



DELTA GEOPHYSICAL SERVICES JANUARY 1986

TERRAIN CONDUCTIVITY SURVEY

AIR FORCE PLANT 4

FORT WORTH, TEXAS

ANOMALOUS ZONES

1

2

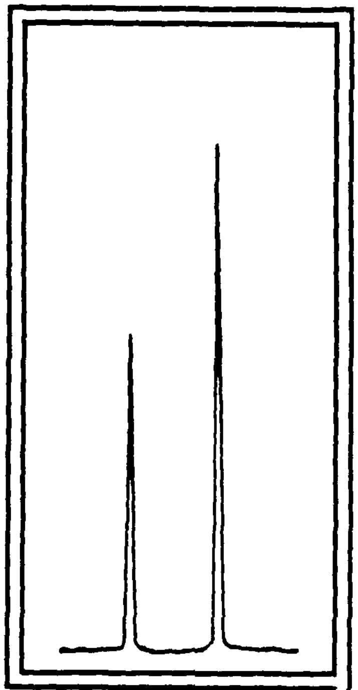
3

4

5

6

7



Shallow Soil Gas Investigation Of
The U.S. Air Force Plant #4
Fort Worth, Texas
February 1986

TRACER RESEARCH CORPORATION

1687 West Grant Road, Suite 102 Tucson, Arizona 85745 (602) 623-0200

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EXECUTIVE SUMMARY

- A total of 28 soil gas samples were collected and anlyzed in the vicinity of a fire training area at Air Force Plant 4, Fort Worth, Texas.

- Soil gas samples were analyzed for the presence of methane, total hydrocarbons, carbon tetrachloride (CCl_4), 1,1,1-trichloroethane (TCA), trichloroethylene (TCE), and perchloroethylene (PCE).

- Methane concentrations as high as 40,000 ug/l were present in soil gas in the northwest section of the study site. The methane plume apparently originiates near a recent fill zone and is confined to the northern part of the site.

- Soil gas concentrations of total hydrocarbons, TCE, and CCl_4 were at or below background levels over the entire site.

- Soil gas concentrations of PCE and TCA exceeded 0.01 ug/l at one point, respectively, possibly indicating very localized and low level soil contamination.

INTRODUCTION

A shallow soil gas investigation was performed by Tracer Research Corporation (TRC) at Air Force Plant #4 in Fort Worth, Texas. The investigation was conducted from February 11 to February 13, 1986, in conjunction with Radian Corporation. The major emphasis of the study was to identify and delineate volatile organic chemicals (VOCs) underlying a fire department training area.

Soils overlying the 20 foot deep groundwater table at the Air Force Plant have been reported to consist of weathered limestone and shale as well as fill dirt. These materials normally have a sufficient air porosity to permit the diffusion and sampling of soil gas contaminants. Although subsurface VOCs have not been identified at the fire training area, both aviation fuels and chlorinated solvents are suspected to have been dumped and burned.

The presence of volatile organic chemicals (VOCs) in shallow soil gas indicates contamination from the observed compounds either in the vadose zone near the probe or in groundwater below the probe. The technology is most effective in mapping low molecular weight halogenated solvent chemicals and petroleum hydrocarbons possessing high vapor pressures and low aqueous solubilities. These compounds readily partition out of the groundwater and into the soil gas as a result of their high gas/liquid partitioning coefficients. Once in the soil gas, VOCs diffuse vertically in response to a chemical concentration gradient where the above-ground atmosphere acts as a sink and the groundwater acts as a source for the compounds. The concentration gradient in soil gas between the water table and ground surface may be locally distorted by hydrologic or geologic anomalies, however, plume mapping is relatively unaffected because of the large number points sampled.

SAMPLING PROCEDURE

TRC utilized an analytical field van which was equipped with two Varian 3300 gas chromatographs and two Spectra-Physics SP4270 computing integrators. In addition, the van has two built-in gasoline powered generators which provide the electrical power (110 volts AC) to operate all of the field equipment. A specialized hydraulic machanism consisting of two cylinders and a set of jaws is used to drive and withdraw the sampling probes. Probes consist of 7 foot lengths of 3/4 inch diameter steel pipe which are fitted with detachable drive points. A percussion hammer was used to assist in driving probes through cobbles or through unusually hard soil. The above-ground ends of sampling probes are fitted with a stainless steel reducer and a length of silicone tubing which leads to a vacuum pump.

Soil gas samples were collected by driving a hollow steel probe from 2 to 12 feet into the ground and evacuating 5 to 10 liters of gas with a vacuum pump. During the soil gas evacuation, samples were collected by inserting a syringe needle through the silicone evacuation line and down into the steel probe. Ten milliliters of gas were collected for immediate analysis in the TRC analytical field van. Soil gas was subsampled (duplicate injections) in volumes ranging from 1 ul to 2 ml, depending on the VOC concentration at any particular location. Detection limits for the halogenated hydrocarbons ranged from 0.00002 to 0.00007 ug/l in soil gas using the electron capture detector, while the limits for petroleum hydrocarbons ranged from 0.01 to 6.0 ug/l using the flame-ionization detector. Detection limits are a function of the injection volume as well as the detector sensitivity for individual compounds. The minimum detectable quantity of halogenated hydrocarbons (e.g. TCA) is about 2.5×10^{-11} grams

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while the minimal detectable quantity of petroleum hydrocarbons (e.g. benzene) is approximately 5×10^{-9} grams.

TRC's normal quality assurance procedures were followed in order to prevent any cross-contamination of soil gas samples. Prior to sampling, syringes were purged with nitrogen (i.e. carrier gas) and checked for contamination by injection into the gas chromatograph. System blanks were run periodically to confirm that there was no contamination in the probes, adaptors or 10 ml syringes. Soil gas probes were used only once during the course of a working day and then thoroughly cleaned before use on the subsequent day. Analytical instruments were continuously checked for calibration by the use of chemical standards prepared in water from commercially available pure chemicals. Soil gas pumping was monitored by a vacuum gauge to ensure that an adequate gas flow from the vadose zone was maintained. A negative pressure (vacuum) greater than 15 in. of Hg usually indicates that a reliable gas sample cannot be obtained because of a clogged probe or because the soil has a very low air porosity.

FIELD INVESTIGATION

Soil gas was collected from a total of 28 sampling points at Air Force Plant #4. The target depth for soil gas sampling was 5 to 6 feet below the ground surface at the majority of probe locations. At 8 of the sampling locations, probes were driven to the 8-12 foot depth interval in order to determine if VOCs were being biodegraded in the shallow soil gas. Petroleum hydrocarbons (e.g. aviation fuel components) are particularly suseptible to oxidative biodegradation in the shallow soil where aerobic conditions prevail. Therefore, sampling for petroleum hydrocarbons is usually conducted at greater depths than is sampling for halocarbons.

Soil gas samples were analyzed for methane, total petroleum hydrocarbons, carbon tetrachloride (CCl_4), 1,1,1-trichloroethane (TCA), trichloroethylene (TCE) and perchloroethylene (PCE). Total petroleum hydrocarbons were defined as C_4 to C_{10} aliphatic and alicyclic compounds as well as benzene, toluene and xylene isomers. These petroleum compounds are the major constituents of aviation fuels. Methane is produced as a by-product of subsurface biodegradation, and the other four compounds (i.e. CCl_4, TCA, TCE and PCE) are the most common industrial solvents.

Soil gas samples were collected at approximately 100 foot intervals over the 600 x 600 foot area. The thickness of fill varied over the fire training site, affecting both sampling depths and the ability to withdraw soil gas.

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RESULTS & DISCUSSION

The distribution and concentration contours (where applicable) of VOCs in soil gas at the fire training area are shown in Figures 1 through 6. Also shown in these figures are the sample locations and corresponding concentrations of each compound(s).

Methane Distribution

Methane was the only component of soil gas at the fire training site which was present at high enough concentrations to permit contouring. Concentration contours suggest that methane is highest near the edge of a recent fill and is confined to the northern portion of the investigation site (Figure 1). Methane concentrations in the 30,000 to 40,000 mg/l range (sampling points SG17 and SG23) represent soil gas which is approximately 5% methane by volume. The presence of methane is probably due to biodegradation of organic matter in the recent fill dirt. Low concentrations of man-made chemicals (e.g. volatile fuels and solvents) discount the possibility that methane production is due to degradation of solvents and fuels.

Total Hydrocarbon Distribution

Concentrations of total petroleum hydrocarbons exceeded the detection limits at only one sampling location in the study area (Figure 2). The 0.06 ug/l concentration in soil gas at SG29 is extremely low and is not necessarily indicative of subsurface contamination. Fire training areas previously studied by TRC have characteristically shown total hydrocarbon levels above 100 ug/l in soil gas. Soil gas was collected as deep as 12 feet below the ground surface; therefore, it is unlikely that sampling difficulties or biodegradation are responsible for the absence of petroleum compounds. The low concentrations of total hydrocarbons further support the hypothesis that the methane plume is not due to biodegradation of aviation fuels.

TCA and PCE Distribution

TCA and PCE concentrations in the ambient air ranged from 0.0002 to 0.002 ug/l over the three days of soil gas sampling. Atmospheric concentrations of TCA and PCE exceeding 0.001 ug/l are usually indicative of a local source and constitute a relatively high background level. VOC concentrations in soil gas are considered significant only if they exceed background levels by at least an order of magnitude. Figures 3 and 4 show that TCA and PCE were encountered in the 0.01 ug/l range at only one sampling point, respectively. TCA was found at 0.01 ug/l along the western fence at SG6, while PCE was analyzed at 0.01 ug/l in soil gas adjacent to the recent fill (i.e. SG17). The presence of these two compounds at the 0.01 ug/l level is not usually indicative of significant contamination in a 20 foot deep aquifer.

TCE and CCl_4 Distributions

A comparison of TCE and CCl_4 concentrations in ambient air and in soil gas (Figures 5 and 6) reveals that subsurface contamination, if any, did not exceed the highest atmospheric background levels. All soil gas concentrations of TCE were below 0.01 ug/l and all CCl_4 concentrations were below 0.001 ug/l. These halocarbon levels are not characteristic of solvent contamination in either soil or groundwater and may actually reflect an atmospheric source.

CONCLUSIONS

Based on the results of soil gas sampling at the fire training area, it is unlikely that there is VOC contamination in the underlying fill dirt. Petroleum and halogenated hydrocarbons were below detection limits over most of the investigation site. If significant VOC contamination is present beneath the fill dirt, one of two factors may be limiting the remote detection capabilities of soil gas sampling. First, the limestone-shale formation overlying the groundwater may be blocking the vertical diffusion of gaseous contaminants from the water table. Secondly, the recent addition of fill material may not have allowed sufficient time for VOCs to diffuse through the overlying soil. On the basis of similar studies completed by TRC, it is unlikely that either situation would result in the VOC concentrations and distribution observed in this investigation.

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Appendix A

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CONDENSED DATA

			CH_2Cl_2			TCA			TCE			PCE		
standard conc.					µg/l			µg/l			µg/l			µg/l
response from			1		area	1		area	1		area	1		area
ul injection			2		area	2		area	2		area	2		area
			3		area	3		area	3		area	3		area
RFs for this sheet					g/area			g/area			g/area			g/area
sample	date	amt inj	area	µg/l	mean	area	µg/l	mean	area	µg/l	mean	area	µg/l	mean
SG1-5'	11/18			<0.0005			<.00006			<0.00006			0.002	
SG1-10'	11/18			<0.0007			<0.00004			<0.00004			0.002	
SG2-5'	11/18			<0.0007			<0.00004			<0.00004			0.002	
SG2-10'	11/18			<0.0007			<0.00004			<0.00004			0.002	
SG3-5'	11/18			<0.0005			<0.00006			<0.00006			0.002	
SG3-10'	11/18			<0.0007			<0.00004			<0.00004			0.002	
SG4-5'	11/19			<0.0003			<0.00005			<0.00004			0.004	
SG4-8'	11/19			<0.00005			<0.00003			<0.00004			0.002	
SG5-5'	11/19			<0.00007			<0.00004			<0.00003			0.005	
SG5-8.5'	11/19			<0.00009			<0.00005			<0.00001			0.01	
SG6-5'	11/19			0.04			0.0006			<0.00004			0.01	
SG6-10'	11/19			0.05			0.002			0.04			0.05	
SG7-5'	11/19			8			<0.002			0.6			0.2	
SG7-8'	11/19			7			<0.003			<0.002			0.3	
SG8-5'	11/19			<0.00005			0.001			<0.003			0.3	
SG8-8'	11/19			<0.00005			0.003			<0.00003			0.005	
SG9-5'	11/19			0.3			0.005			0.00005			0.004	
SG10-5'	11/19			0.3			0.2			0.03			11	

Notations:
- RF response factor
- I interference with adjacent peaks
- NA not analysed
- E estimated peak area

Analysed by D. Evans

Checked by T. Schreiner

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Job Radian - Tracy Defense Depot

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CONDENSED DATA

			CH_2Cl_2			TCA			TCE			PCE		
standard conc.				µg/l			µg/l			µg/l			µg/l	
response from			1	area		1	area		1	area		1	area	
ul injection			2	area		2	area		2	area		2	area	
			3	area		3	area		3	area		3	area	
RFs for this sheet				g/area			g/area			g/area			g/area	
sample	date	amt inj	area	µg/l	mean	area	µg/l	mean	area	µg/l	mean	area	µg/l	mean
SG10-10'	11/19			1			1			5			79	
SG11-6'	11/19			<0.00002			0.0008			<0.0001			0.04	
SG12-5.5'	11/19			<.0001			0.0004			0.02			0.07	
SG13-6'	11/19			.0001			0.0003			<0.0001			0.07	
SG14-6'	11/20			<0.0001			<0.00006			<0.0001			0.03	
SG15-6'	11/20			.08			<0.006			10			21	
SG16-6'	11/20			.03			0.007			0.005			0.02	
SG17-6'	11/20						<0.00005			0.0007			0.0014	
SG18-6'	11/20			<0.0001			0.0006			0.002			0.009	
SG19-6'	11/20			<0.0002			<0.00004			0.0008			0.1	
SG20-6'	11/20			<0.0001			0.0006			0.0002			0.01	
SG21-6'	11/20			0.03			<0.008			<0.02			6	
SG22-6'	11/20			3			<0.0003			0.002			0.002	
SG23-6'	11/20			<0.0004			<0.0005			<0.0004			0.3	
SG24-6'	11/20			<0.0002			0.0004			0.003			0.005	
SG25-6'	11/20			0.5			0.0001			<0.0004			0.0008	
SG26-6'	11/20			<0.0002			0.06			<0.0001			0.002	
SG27-6'	11/21			<0.003			<0.00005			<0.00008				

Notations:
RF response factor
I interference with adjacent peaks
NA not analysed
E estimated peak area

Analysed by D. Evans

Checked by T. Schreiner

Job Radian - Tracy Defense Depot

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CONDENSED DATA

			CH_2Cl_2			TCA			TCE			PCE		
standard conc.					µg/l			µg/l			µg/l			µg/l
response from			1		area	1		area	1		area	1		area
ul injection			2		area	2		area	2		area	2		area
			3		area	3		area	3		area	3		area
RFs for this sheet					g/area			g/area			g/area			g/area
sample	date	amt inj	area	µg/l	mean	area	µg/l	mean	area	µg/l	mean	area	µg/l	mean
SG28-6'	11/21			<0.06			<0.0006			<0.001			0.4	
SG29-6'	11/21			11			<0.0001			0.006			0.003	
SG30-6'	11/21			1			<0.0004			<0.002			0.9	
SG31-6'	11/21			5			0.4			120			2	
SG32-6'	11/21			0.7			0.005			<0.0002			0.001	
SG33-6'	11/21			<0.01			0.03			<0.0001			0.004	
SG34-6'	11 21			<0.08			<0.00005			<0.0003			0.0004	
SG35-6'	11/21			<0.08			<0.00005			<0.00003			0.0005	
SG36-6'	11/21			<0.01			<0.00007			<0.0001			0.0006	
SG37-6'	11/21			<0.01			<0.00006			<0.0001			0.04	
SG38-6'	11/21			<0.04			<0.0002			0.5			0.02	
SG39-6'	11/21			<0.01			0.05			<0.0001			0.002	
SG40-6'	11/21			<0.008			0.005			<0.0001			0.0005	
SG41-6'	11/21			<0.01			<0.00008			0.003			0.01	
SG42-6'	11/21			<0.008			0.0003			0.0005			0.002	
SG43-6'	11/21			0.08			<0.00007			<0.001			0.0007	
SG44-6'	11/21			3			0.01			0.002			0.0008	
SG45-6'	11/21			4			0.005			0.001			0.001	

Notations:
RF response factor
I interference with adjacent peaks
NA not analysed

Analysed by D. Evans

Job Radian - Tracy Defense Depot

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CONDENSED DATA

			CH_2Cl_2			TCA			TCE			PCE		
standard conc.					µg/l			µg/l			µg/l			µg/l
response from			1		area	1		area	1		area	1		area
ul injection			2		area	2		area	2		area	2		area
			3		area	3		area	3		area	3		area
RFs for this sheet					g/area			g/area			g/area			g/area
sample	date	amt inj	area	µg/l	mean	area	µg/l	mean	area	µg/l	mean	area	µg/l	mean
SG46-6'	11/21			<0.02			<0.0002			0.05			2	
SG47-6'	11/22			<0.009			0.0005			<0.0001			0.0006	
SG48-6'	11/22			<0.008			<0.00005			<0.00009			0.002	
SG49-6'	11/22			<0.3			<0.004			19			0.1	
SG50-6'	11/22			<0.1			0.004			<0.0002			4	
SG51-6'	11/22			<0.02			0.03			<0.0004			0.2	
SG52-6'	11/22			0.7			0.002			<0.0001			0.003	
SG53-6'	11/22			<0.01			<0.00005			<0.00008			0.0004	
SG54-6'	11/22			<0.006			<0.00004			<0.00006			0.0004	
SG55-6'	11/22			0.9			0.0003			<0.0002			0.007	
SG56-6'	11/22			4			2			0.8			0.08	
SG57-6'	11/22			<0.01			<0.0002			<0.0002			0.007	
SG58-4.5'	11/22			0.4			0.0003			<0.0002			0.004	
SG59-6'	11/22			<0.02			<0.0001			0.003			0.1	
SG60-6'	11/22			0.7			0.3			<0.0002			0.1	
SG61-6'	11/22			150			4			210			9	
SG62-6'	11/22			<0.05			0.001			<0.0001			0.002	
SG63-6'	11/22			0.3			0.0002			0.0002			0.002	

Notations:
RF response factor
I interference with adjacent peaks
NA not analysed
F estimated peak area

Analysed by D. Evans

Checked by T. Schreiner

Job Radian - Tracy Defense Depot

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CONDENSED DATA

			CH_2Cl_2			TCA			TCE			PCE		
standard conc.				μg/l			μg/l			μg/l			μg/l	
response from ul injection			1	area		1	area		1	area		1	area	
			2	area		2	area		2	area		2	area	
			3	area		3	area		3	area		3	area	
RFs for this sheet				g/area			g/area			g/area			g/area	
sample	date	amt inj	area	μg/l	mean	area	μg/l	mean	area	μg/l	mean	area	μg/l	mean
SG64-6'	11/22			1			0.2			<0.0002				
SG65-6'	11/22			<0.02			0.02			<0.0002			2	
SG66-6'	11/22			<0.01			<0.0001			0.004			0.009	
SG67-6'	11/23			<0.01			0.001			0.004			0.008	
SG68-6'	11/23			<0.01			0.008			<0.0001			0.004	
SG69-6'	11/23			8			0.002			<0.0004			0.02	
SG70-6'	11/23			3			0.04			2			0.8	
SG71-6'	11/23			<0.006			<0.00002			<0.00005			0.003	
SG72-6'	11/23			<0.02			0.0005			0.0008			0.0005	
SG73-6'	11/23			<0.01			0.001			<0.0001			0.0003	
SG74-6'	11/23			<2			0.008			<0.03			0.02	
SG75-6'	11/23			0.4			<0.0003			0.08			15	
SG76-6'	11/23			4			0.1			0.05			0.2	
SG77-6'	11/23			<0.02			<0.0002			<0.0004			0.0002	
SG78-6'	11/23			<0.02			0.001			<0.0002			0.04	
SG79-6'	11/23			3			0.02			0.02			0.03	
SG80-6'	11/20			<0.02			<0.0004			<0.001			15	
SG81-6'	11/20			<0.02			<0.0004			<0.001			0.002	
													0.003	

Notations:
- RF response factor
- I interference with adjacent peaks
- NA not analysed
- E estimated peak area

Analysed by J. Coffey

Checked by D. Evans

Job Radian - Tracy Defense Depot

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CONDENSED DATA

			CH_2Cl_2			TCA			TCE			PCE		
standard conc.					µg/l			µg/l			µg/l			µg/l
response from			1		area	1		area	1		area	1		area
ul injection			2		area	2		area	2		area	2		area
			3		area	3		area	3		area	3		area
RFs for this sheet					g/area			g/area			g/area			g/area
sample	date	amt inj	area	µg/l	mean	area	µg/l	mean	area	µg/l	mean	area	µg/l	mean
SG82-6'	11/20			<0.004			<0.0004			0.002			0.03	
SG83-6'	11/20			<0.02			0.002			<0.001			0.009	
SG84-6'	11/20			<0.02			<0.0004			<0.001			<0.0002	
SG85-6'	11/20			<0.02			0.003			<0.001			0.002	
SG86-6'	11/20			<0.02			<0.0004			<0.001			<0.0004	
SG87-6'	11/20			<0.02			<0.0004			<0.001			0.02	
SG88-6'	11/20			<0.02			<0.0004			<0.001			<0.0002	
SG89-6'	11/20			<0.02			<0.0004			<0.001			<0.0002	
SG90-6'	11/20			<0.02			<0.0004			<0.001			0.006	

Notations:
RF response factor
I interference with adjacent peaks
NA not analysed
E estimated peak area

Analysed by J. Coffey

Checked by D. Evans

Job Radian - Tracy Defense Depot

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CONDENSED DATA

			Benzene			Toluene			Ethyl Benzene/Xylenes					
standard conc.					μg/l			μg/l			μg/l			μg/l
response from			1		area	1		area	1		area	1		area
ul injection			2		area	2		area	2		area	2		area
			3		area	3		area	3		area	3		area
RFs for this sheet					g/area			g/area			g/area			g/area
sample	date	amt inj	area	μg/l	mean	area	μg/l	mean	area	μg/l	mean	area	μg/l	mean
SG1-5'	11/18			<0.03			<0.03			<0.03				
SG1-10'	11/18			<0.03			<0.03			<0.03				
SG2-5'	11/18			<0.03			<0.03			<0.03				
SG2-10'	11/18			<0.04			<0.03			<0.03				
SG3-5'	11/18			<0.03			<0.03			<0.03				
SG3-10'	11/18			<0.03			<0.03			<0.03				
SG4-5'	11/19			<0.03			<0.04			<0.04				
SG4-10'	11/19			<0.03			<0.04			<0.04				
SG5-4.5'	11/19			<0.03			<0.04			<0.04				
SG6-5'	11/19			<0.03			<0.04			<0.04				
SG6-10'	11/19			<0.03			<0.04			<0.04				
SG7-5'	11/19			<0.03			<0.04			<0.04				
SG7-8'	11/19			<0.03			<0.04			<0.04				
SG8-5'	11/19			<0.03			<0.04			<0.04				
SG8-8'	11/19			<0.03			<0.04			<0.04				
SG9-10'	11/19			<0.03			<0.04			<0.04				
SG10-5'	11/19			<0.03			<0.04			<0.04				
SG10-10'	11/19			<0.03			<0.04			<0.04				

Notations:
RF response factor
I interference with adjacent peaks
NA not analysed
E estimated peak area

Analysed by D. Evans

Checked by T. Schreiner

Job Radian - Tracy Defense Depot

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CONDENSED DATA

			Benzene			Toluene			Ethyl Benzene/Xylene					
standard conc.					μg/l			μg/l			μg/l			μg/l
response from			1		area	1		area	1		area	1		area
ul injection			2		area	2		area	2		area	2		area
			3		area	3		area	3		area	3		area
RFs for this sheet					g/area			g/area			g/area			g/area
sample	date	amt inj	area	μg/l	mean	area	μg/l	mean	area	μg/l	mean	area	μg/l	mean
SG11-6'	11/19			<0.03			<0.04			<0.04				
SG12-5.5'	11/19			<0.03			<0.04			<0.04				
SG13-6'	11/19			<0.03			<0.04			<0.04				
SG14-6'	11/20			<0.03			<0.04			<0.04				
SG15-6'	11/20			<0.03			<0.04			<0.04				
SG16-6'	11/20			<0.03			<0.04			<0.04				
SG17-6'	11/20			<0.03			<0.04			<0.04				
SG18-6'	11/20			<0.03			<0.04			<0.04				
SG19-6'	11/20			<0.03			<0.04			<0.04				
SG20-6'	11/20			<0.03			<0.04			<0.04				
SG21-6'	11/20			<0.03			<0.04			<0.04				
SG22-6'	11/20			<0.03			<0.04			<0.04				
SG23-6'	11/20			<0.03			<0.04			<0.04				
SG24-6'	11/20			<0.03			<0.04			<0.04				
SG25-6'	11/20			<0.03			<0.04			<0.04				
SG26-6'	11/20			<0.03			<0.04			<0.04				
SG27-6'	11/21			<0.03			<0.04			<0.04				
SG28-6'	11/21			<0.03			<0.04			<0.04				

Notations:
- RF response factor
- I interference with adjacent peaks
- NA not analysed
- E estimated peak area

Analysed by D. Evans

Checked by T. Schreiner

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Job Radian - Tracy Defense Depot

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CONDENSED DATA

			Benzene			Toluene			Ethyl Benzene/Xylenes					
standard conc.					µg/l			µg/l			µg/l			µg/l
response from			1		area	1		area	1		area	1		area
ul injection			2		area	2		area	2		area	2		area
			3		area	3		area	3		area	3		area
RFs for this sheet					g/area			g/area			g/area			g/area
sample	date	amt inj	area	µg/l	mean	area	µg/l	mean	area	µg/l	mean	area	µg/l	mean
SG29-6'	11/21			<0.03			<0.04			<0.04				
SG30-6'	11/21			<0.03			<0.04			<0.04				
SG31-6'	11/21			<0.03			<0.04			<0.04				
SG32-6'	11/21			<0.03			<0.04			<0.04				
SG33-6'	11/21			<0.03			<0.04			<0.04				
SG34-6'	11/21			<0.03			<0.04			<0.04				
SG35-6'	11/21			<0.03			<0.04			<0.04				
SG36-6'	11/21			<0.03			<0.04			<0.04				
SG37-6'	11/21			<0.03			<0.04			<0.04				
SG38-6'	11/21			<0.03			<0.04			<0.04				
SG39-6'	11/21			<0.03			<0.04			<0.04				
SG40-6'	11/21			<0.03			<0.04			<0.04				
SG41-6'	11/21			<0.03			<0.04			<0.04				
SG42-6'	11/21			<0.03			<0.04			<0.04				
SG43-6'	11/21			<0.03			<0.04			<0.04				
SG44-6'	11/21			<0.03			<0.04			<0.04				
SG45-6'	11/21			<0.03			<0.04			<0.04				
SG46-6'	11/21			<0.03			<0.04			<0.04				

Notations:
RF response factor
I interference with adjacent peaks
NA not analysed
E estimated peak area

Analysed by D. Evans

Checked by T. Schreiner

Job Radian - Tracy Defense Depot

TRACER RESEARCH CORPORATION

I-77

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CONDENSED DATA

			Benzene			Toluene			Ethyl Benzene/Xylenes					
standard conc.					µg/l			µg/l			µg/l			µg/l
response from			1		area	1		area	1		area	1		area
ul injection			2		area	2		area	2		area	2		area
			3		area	3		area	3		area	3		area
RFs for this sheet					g/area			g/area			g/area			g/area
sample	date	amt inj	area	µg/l	mean	area	µg/l	mean	area	µg/l	mean	area	µg/l	mean
SG80-6'	11/20			<0.03			<0.02			<0.4				
SG81-6'	11/20			<0.03			<0.02			<0.4				
SG82-6'	11/20			< 0.2			< 0.2			<0.4				
SG83-6'	11/20			<0.03			<0.02			<0.4				
SG84-6'	11/20			<0.03			<0.02			<0.4				
SG85-6'	11/20			<0.03			<0.02			<0.4				
SG87-6'	11/20			<0.03			<0.02			<0.4				
SG88-6'	11/20			<0.03			<0.02			<0.4				
SG89-6'	11/20			<0.03			<0.02			<0.4				
SG90-6'	11/20			<0.03			<0.02			<0.4				

Notations:
- RF response factor
- I interference with adjacent peaks
- NA not analysed
- E estimated peak area

Analysed by J. Coffey

Checked by D. Evans

FIGURE 1.

AIR FORCE PLANT #4, FORT WORTH, TEXAS

METHANE CONTOURS

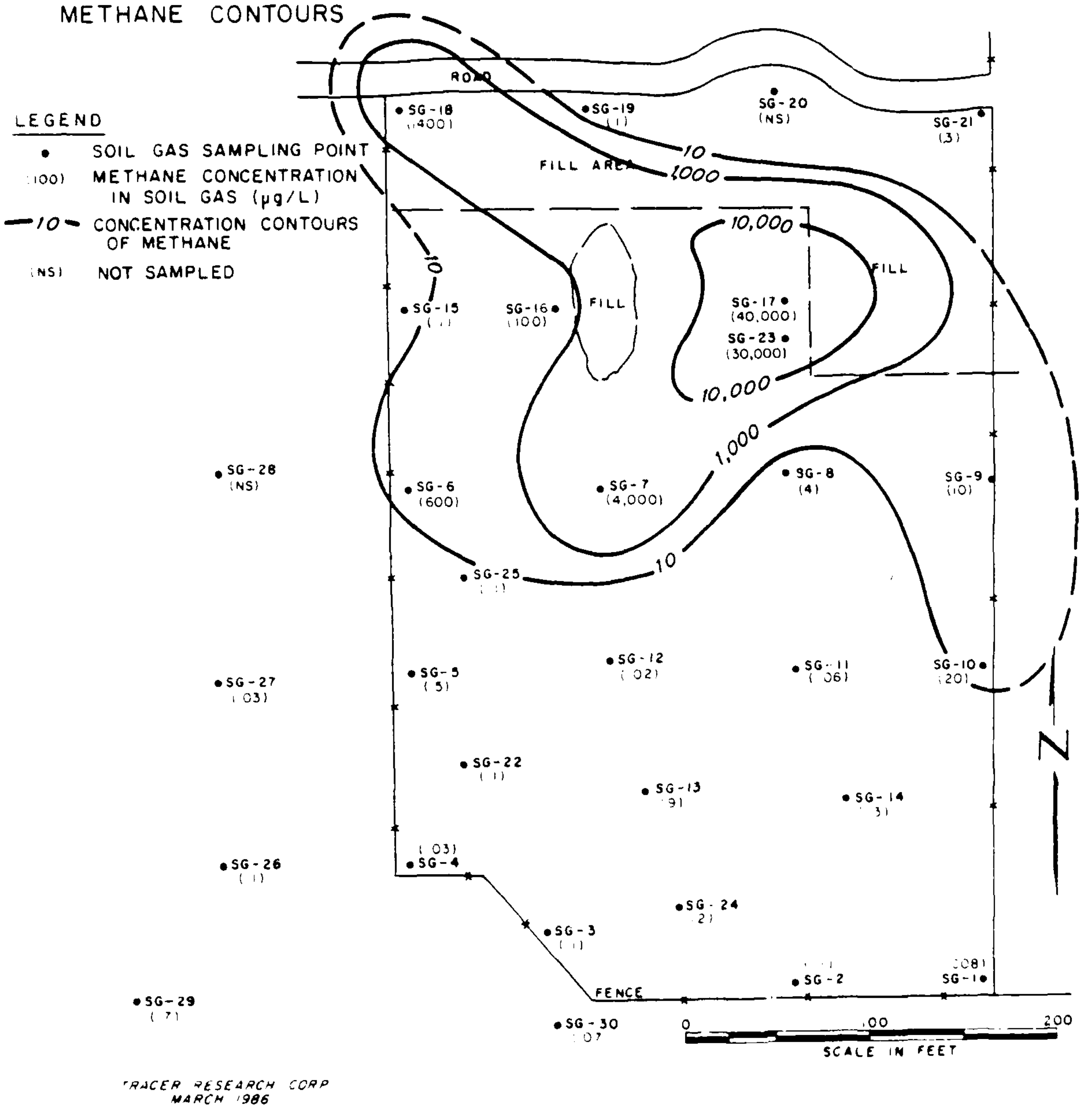


FIGURE 2

AIR FORCE PLANT #4, FORT WORTH, TEXAS

TOTAL HYDROCARRON DISTRIBUTION

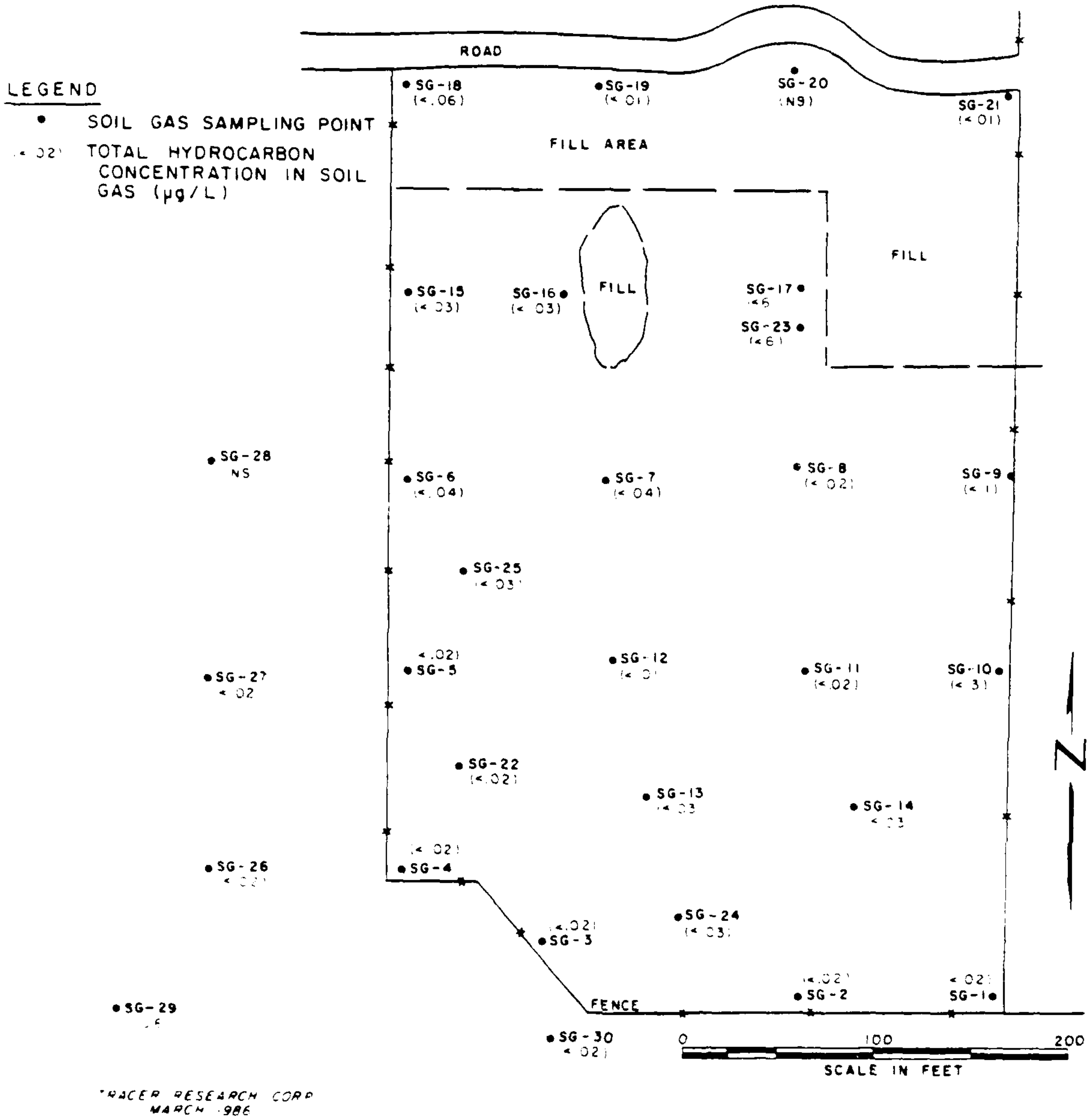
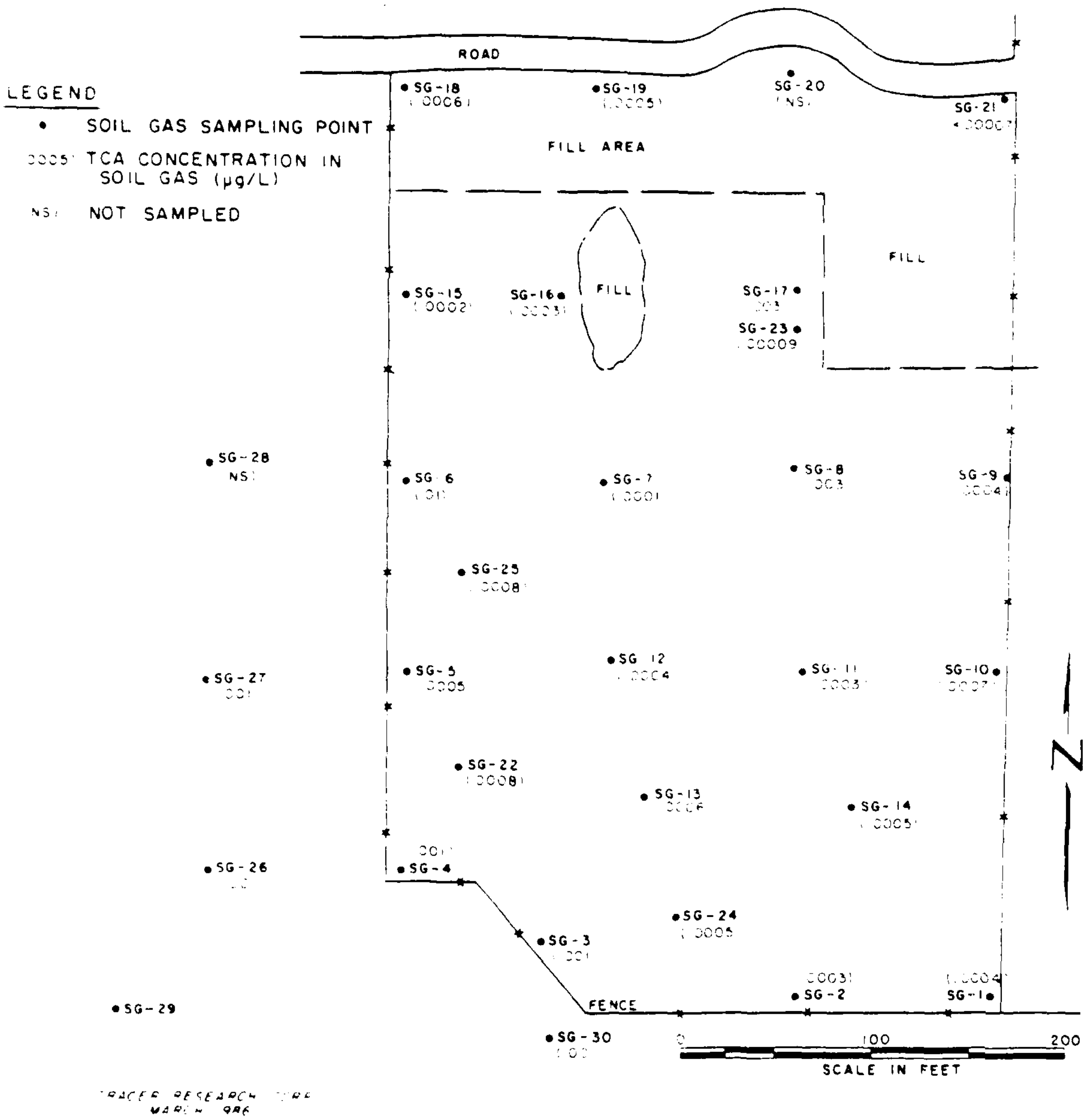


FIGURE 3
AIR FORCE PLANT #4, FORT WORTH, TEXAS
TCA DISTRIBUTION



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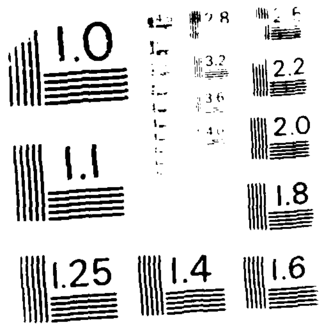

1.0
2.8
2.5
3.2
2.2
3.6
2.0
1.1
1.8
1.25
1.4
1.6

FIGURE 4.
AIR FORCE PLANT #4, FORT WORTH, TEXAS
PCE DISTRIBUTION

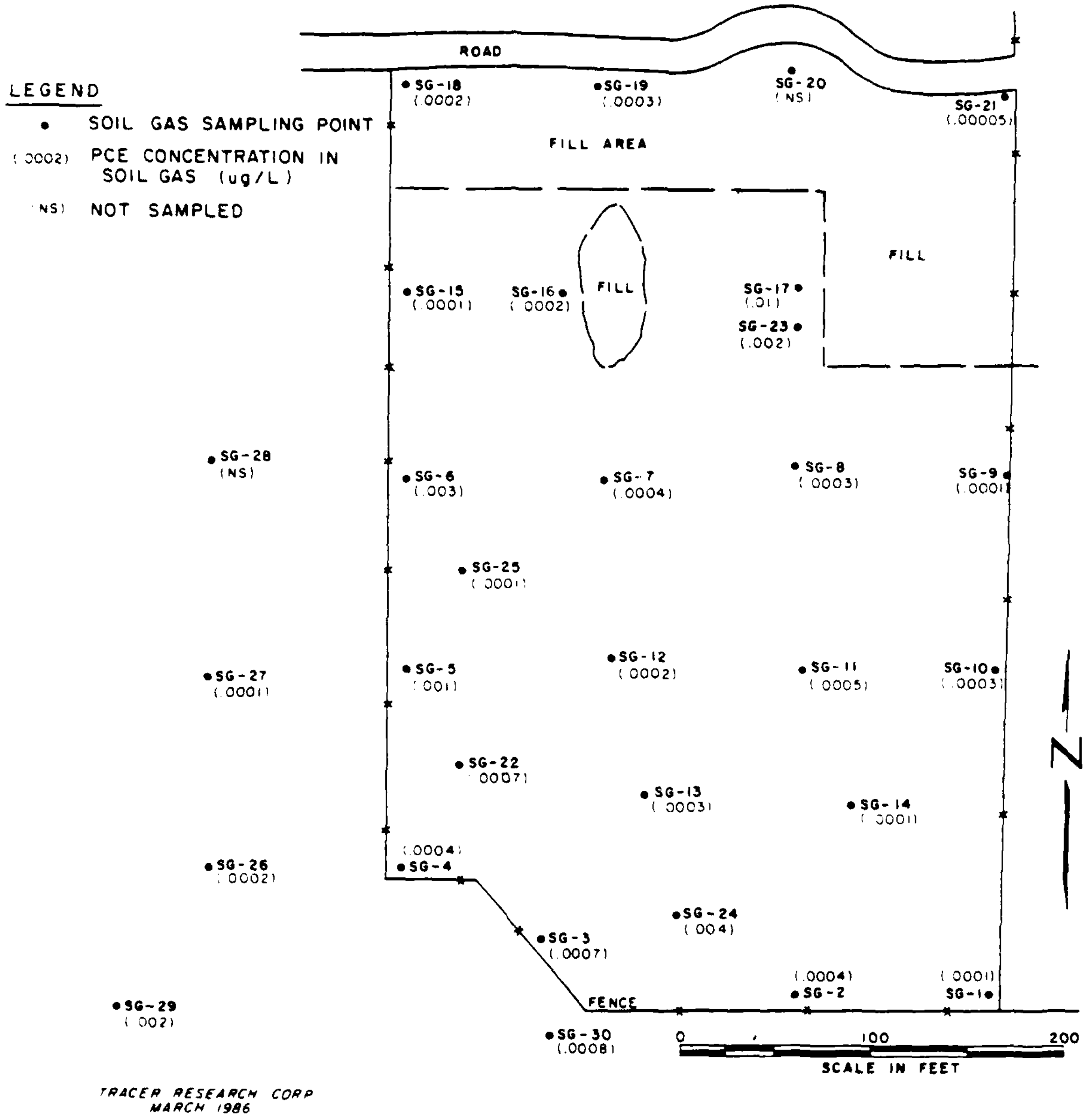


FIGURE 5.
AIR FORCE PLANT #4, FORT WORTH, TEXAS
TCE DISTRIBUTION

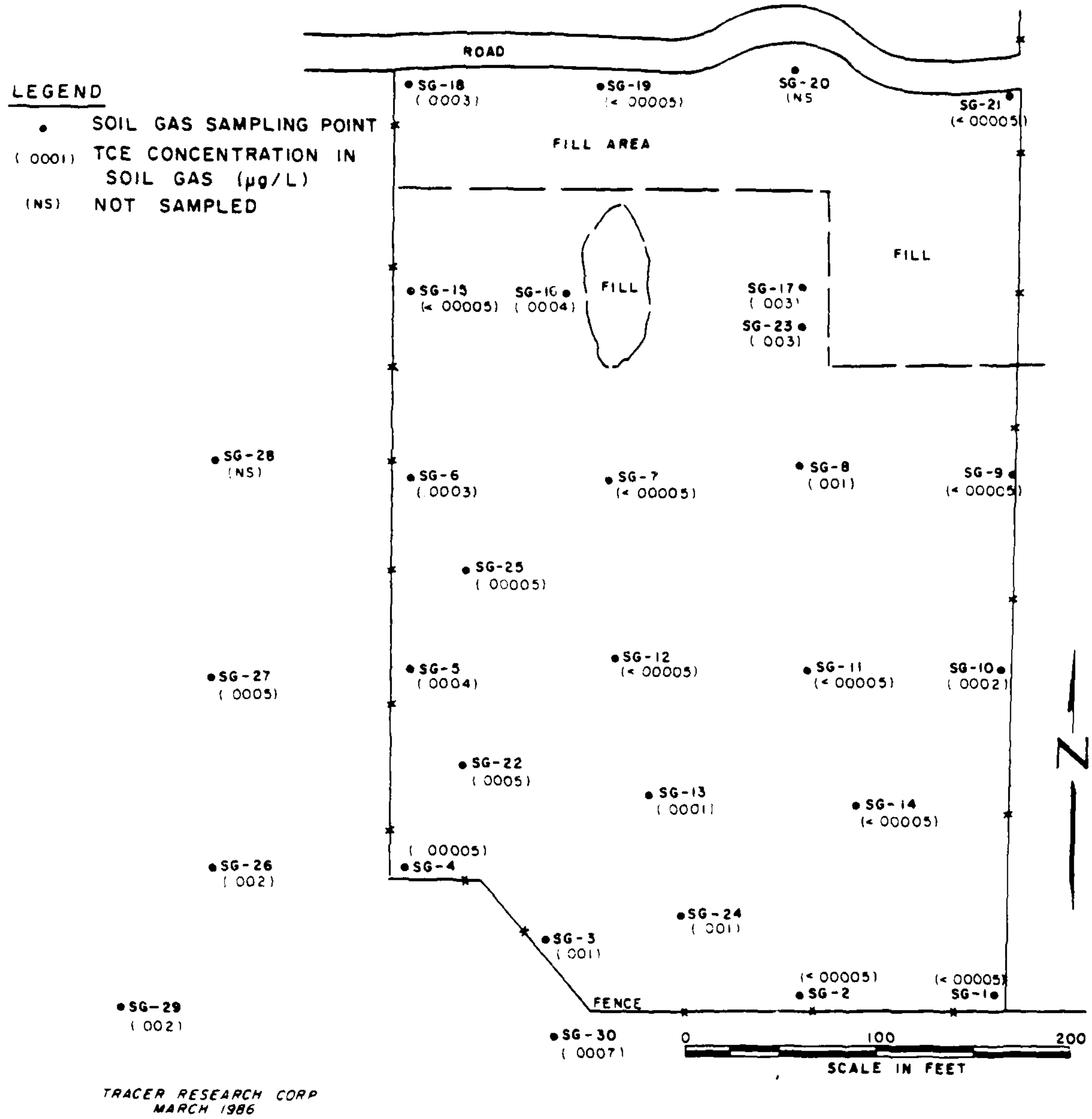
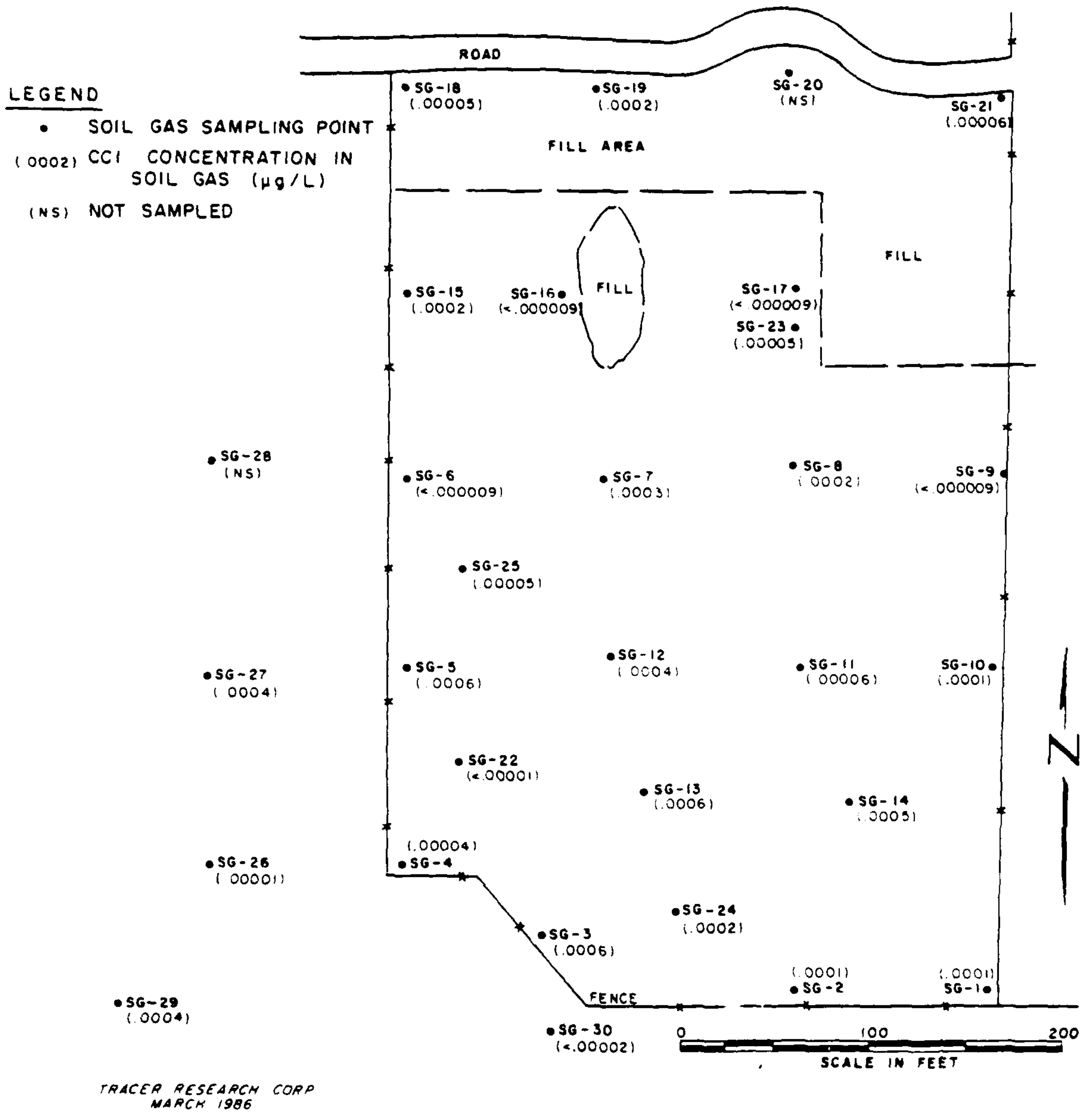


FIGURE 6.
AIR FORCE PLANT #4, FORT WORTH, TEXAS
CCl_4 DISTRIBUTION



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APPENDIX J

Health and Safety Plan

(Included in Technical Operations Plan, Appendix K)

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APPENDIX K

Technical Operations Plan

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212-027-27

Delivery Order No. 27

INSTALLATION RESTORATION PROGRAM
PHASE II-CONFIRMATION/QUANTIFICATION
STAGE 1

TECHNICAL OPERATIONS PLAN
AIR FORCE PLANT 4

FORT WORTH, TEXAS

Prepared by:

Radian Corporation

Under Contract

F33615-83-D-4001

Submitted to:

UNITED STATES AIR FORCE
Occupational and Environmental Health Laboratory
Brooks AFB, Texas 78235

10 January 1986

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NOTICE

This report has been prepared for the United States Air Force by Radian Corporation, Austin, Texas, for the purpose of aiding in the implementation of the Air Force Installation Restoration Program. It is not an endorsement of any product. The views expressed herein are those of the contractor and do not necessarily reflect the official views of the publishing agency, the United States Air Force, nor the Department of Defense.

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1.0 INTRODUCTION

1.1 Background

In 1975, the Department of Defense developed the Installation Restoration Program (IRP) to identify, report, and correct potential environmental deficiencies from past waste management activities that could result in groundwater contamination and probably contaminant migration beyond DOD installation boundaries. The IRP is a four-phase program consisting of Phase I, Problem Identification/Records Search; Phase II, Confirmation and Quantification; Phase III, Technology Development; and Phase IV, Corrective Action. The identification of hazardous waste disposal sites at Air Force installations was directed by Defense Environmental Quality Program Policy Memorandum 81-5 (DEQPPM 81-5) dated 11 December 1981, and implemented by Headquarters Air Force message dated 21 January 1982.

The initial effort in Phase II consists of a Presurvey to review the results of the Phase I study and other investigations, develop a work plan for the Phase II Stage 1 investigation, and provide an estimate of costs for the Phase II Stage 1 activities. According to recent guidance from Technical Services staff at USAF OEHL Brooks AFB, the Phase II program consists of two stages. Stage 1 is designed to provide information regarding the presence or absence of contamination of identified waste sites. Detailed quantitative studies can be conducted if enough is known about the features of the site and the characteristics of wastes. Based on the results of Stage 1, more detailed, quantitative investigations may be performed in Phase II, Stage 2, if necessary.

Location of AF Plant 4

AF Plant 4 is located seven miles west of the center of Fort Worth in Tarrant County, Texas (Figure 1-1). It is a government-owned aircraft

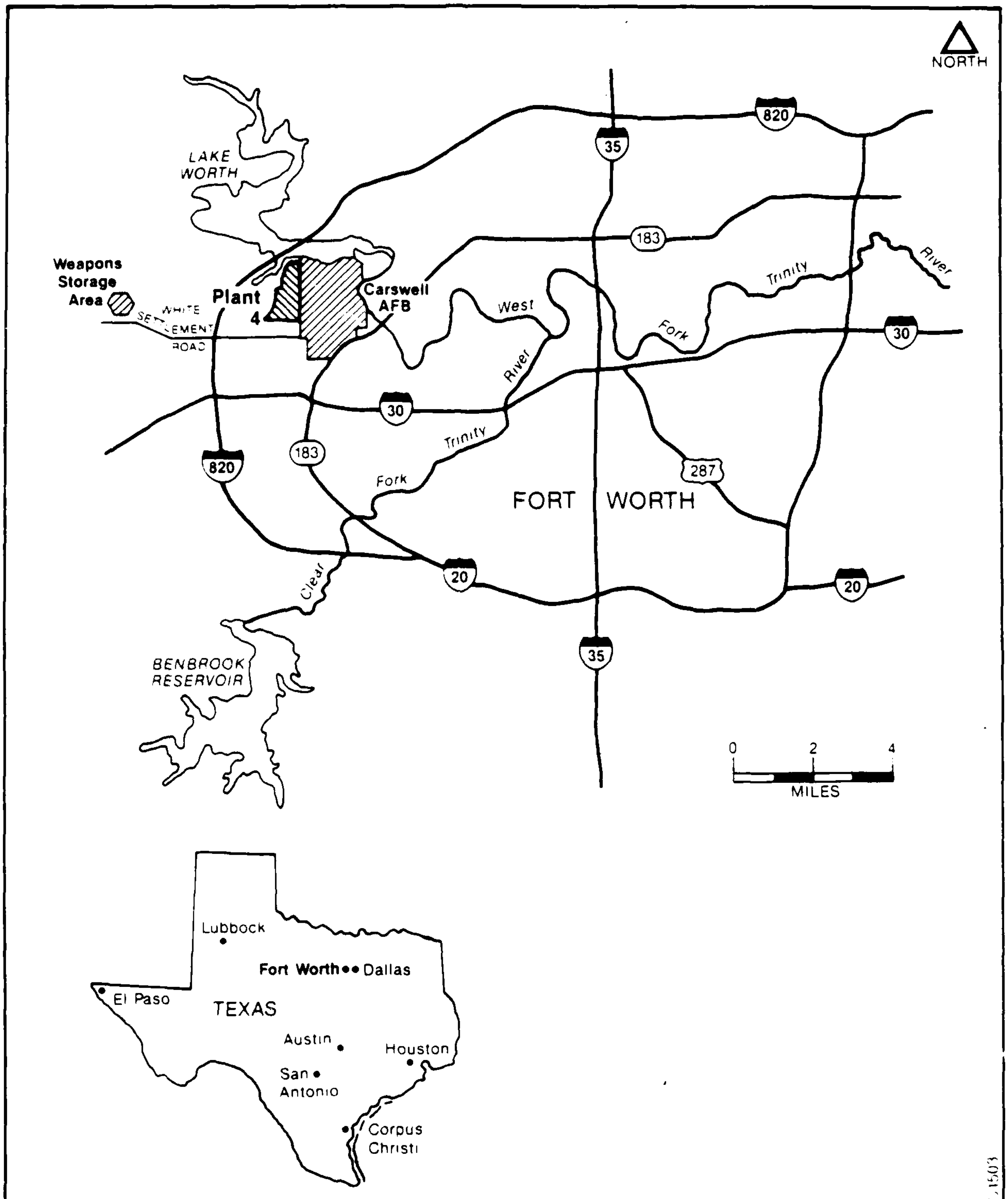

Figure 1-1. Location Map of AF Plant 4.

production facility operated under contract by the General Dynamics Corporation (GD). The major facilities and physical features of the AF Plant 4 site are shown on Figure 1-2.

Purpose of the Phase II Stage 1 Investigation

The overall objective of the AF Plant 4 Phase II Stage 1 investigation is to define the presence, magnitude, direction, rate of movement, and extent of any identified contaminants. In addition, the body of geologic, hydrologic, and chemical data developed by General Dynamics will be incorporated into the investigation. The contractor will also determine the technical approach and estimated cost of any additional investigations required beyond this stage.

A contaminant source investigation at AF Plant 4 will be conducted to determine: (1) the presence or absence of contamination within the specified areas of the field survey; (2) if contamination exists, the potential for migration in the various environmental media; (3) the extent/magnitude of contamination on AF Plant 4 property; and (4) potential environmental consequences and health risks of migrating contaminants based on state or federal standards for these contaminants in light of potential use of the ground water. The planning for this investigation is based upon the Statement of Work (Appendix A), an inspection of the disposal sites and monitoring locations at AF Plant 4, and a review of data generated from previous studies.

Previous Investigations at Plant 4

General Dynamics Corporation (GD) has conducted a series of investigations that have been structured in a way similar to the DOD IRP organization. A GD Phase I investigation was initiated in late 1982 in order to define waste disposal sites of concern and provided the basis for non-DOD Phase II field activities that have been conducted at the Plant. The GD Phase II work began in 1983 and has consisted of drilling and monitor well

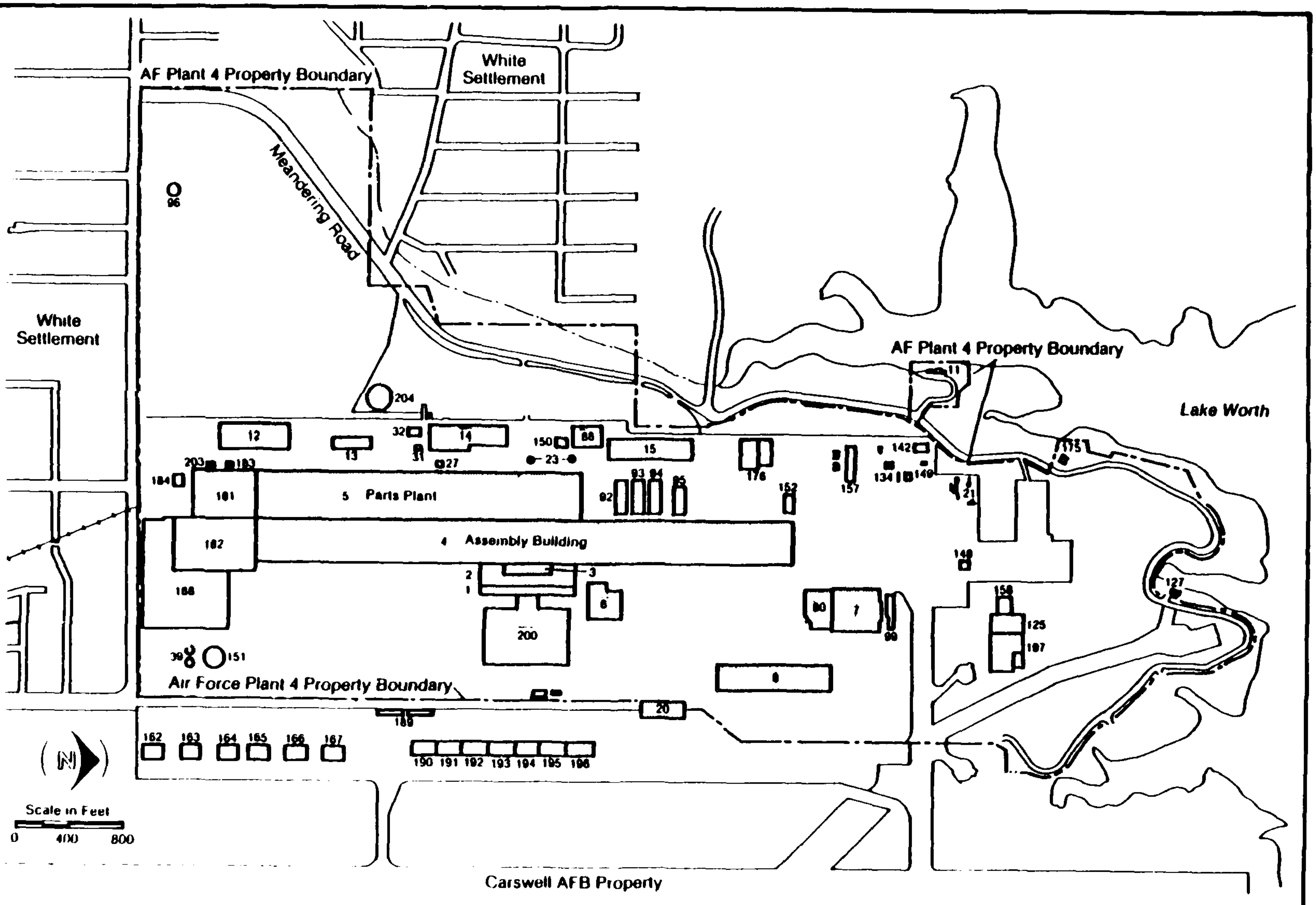

Figure 1-2. Major Features of AF Plant 4.

installation, both in the terrace deposits of the Trinity River (Upper Zone) and the Paluxy Formation. Sampling and analysis of ground water from wells, both on-site and off-site, is continuing on a regular schedule. The GD Phase II activities began in 1983 and continued through Spring, 1985. These investigations have been conducted by Hargis & Associates, Inc., ("H&A") (formerly Hargis & Montgomery, Inc.) under contract to General Dynamics Corporation.

Several Paluxy monitor wells have been installed by the Army Corps of Engineers in 1985. These wells are located in the southeastern portion of the site, and are designed to supply ground-water data on the occurrence of contamination downgradient of the plant. Geologic and water-quality data from these wells will be used in the IRP investigation.

Since the initial program started by General Dynamics, the efforts at Plant 4 have been incorporated into the DOD IRP organization. A Phase I investigation for Plant 4 was completed in August 1984 and included a description of the environmental setting, a description of the plant operations and waste disposal activities, a prioritization of waste sites based on Hazard Assessment Rating Methodology (HARM) rankings, and recommendations for Phase II monitoring.

1.2 Summary of Phase II Stage 1 Activities

The following paragraphs summarize, by activity, the work that will be conducted to confirm and quantify to the extent possible the magnitude, direction, rate of movement and extent of potential contamination. The Statement of Work (Appendix A) contains specific and detailed descriptions of the work on a site-by-site basis. The following activities will be performed at AF Plant 4:

- Twenty (20) borings will be made at various sites up to a maximum total of 950 linear feet. The boreholes will be completed in the Upper Zone by hollow-stem auger, with split-spoon

samples collected at 5-foot intervals. The boreholes completed in the upper member of the Paluxy Formation will be drilled by air rotary. If caving or borehole stability problems are encountered in the Paluxy, conversion to mud rotary drilling may be necessary.

- Twelve (12) ground-water monitoring wells will be installed up to a maximum total of 820 linear feet. PVC flush joint casing and PVC commercially manufactured screen will be used for all monitor wells with Schedule 40 PVC for Upper Zone wells and Schedule 80 PVC for Paluxy wells.

- Geophysical surveys, using electromagnetic profiling, will be performed at three sites in order to determine the subsurface geometry of the disposal area and the extent of contamination.

- A soil gas survey will be performed in the suspected vicinity of a fire training area at the north side of the plant.

- The effects of ground-water withdrawals by the City of White Settlement on the direction of ground-water flow in the Paluxy aquifer will be evaluated. The position and shape of any "cone of depression" will be evaluated in terms of possible migration of contaminants in ground water. The evaluation will be directed toward interpreting existing pumping records of White Settlement and aquifer characteristics determined from ongoing studies at AF Plant 4.

- Ground-water quality data and locations of existing monitor wells at AF Plant 4 will be evaluated in order to develop an appropriate, long-term monitoring network. Kriging will be used to determine which wells might be used most effectively for long-term monitoring. Wells shown to provide only

redundant data will be recommended for exclusion from long-term monitoring.

- o Surface-water and ground-water samples will be collected and analyzed. The Quality Control program will include duplicates and blanks for chemical analyses.

- o Split samples of soil and water will be provided to the USAF OEHL.

The preliminary drilling and monitor well locations are provided in the following sections and in Appendix A. The exact locations will be finalized prior to start-up of field activities, pending utility clearances and plant operational considerations. GD is presently developing a proposed monitoring program for 1986. The Phase II Stage 1 work will be closely coordinated with GD in order to avoid unnecessary duplication of sampling efforts.

A draft report will be prepared after the field activities have been completed and the various samples analyzed. This report will document the project activities, provide results and interpretations, and present at least two conceptual remedial alternatives for each site. The draft report will be coordinated through the Air Force Regional Civil Engineer with Federal, state, and local regulatory agencies as well as Air Force and General Dynamics personnel.

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2.0 SITE DESCRIPTIONS AND FIELD ACTIVITIES

A total of 21 individual sites or zones will be investigated during the Phase II Stage 1 field program. These sites or zones are listed on Table 2-1. Data from sites with several different work activities (e.g., geophysical survey followed by drilling program) will be carefully reviewed in the field so that any needed adjustments in the scope of work may be quickly accomplished. In addition, several sites will be the subject of Remedial Action Planning (Phase IV of the IRP) during this investigation. All work at these sites will be coordinated with the Phase IV contractor, Fluor Technology, Inc.

Brief descriptions of these sites and the planned IRP Phase II, Stage 1 activities are contained in the following sections. Site maps for Phase II Stage 1 sites showing existing and planned monitor well locations are provided in the appropriate section. Proposed monitor locations may be revised if warranted by considerations of physical layout and most recent hydrogeologic data. Table 2-2 summarizes the analytical parameters and number of samples to be collected and analyzed at each site.

2.1 Site No. 1, Landfill No. 1

Several types of hazardous and non-hazardous wastes were reportedly disposed of in Landfill No. 1 (Figure 2-1). These wastes included drums of liquid and contents of tanks and bousers loaded with chemical wastes (solvents, thinners, paints, etc.). Contaminated oils, fuels and hazardous wastes containing metals (e.g., mercury, magnesium, etc.), chromate sludges, and cyanide are suspected to be present at this site.

Extensive remedial actions have been conducted at this site since it was closed during the 1960s. The major action was the removal of 11,000 cubic yards of earth and the installation of a drain field (French Drain No. 2). Continued monitoring has shown that contamination still remains in the upper zone ground water. Based on studies completed to date, contaminants

TABLE 2-1. PHASE II, STAGE 1 SITES AT AF PLANT 4.

Site 1, Landfill 1
Site 3, Landfill 3
Site 12, Chrome Waste Pit 3
Site 17, Former Fuel Storage Site
Site 2, Landfill 2
Site 4, Landfill 4
Site 15, Fuel Saturation Area (FSA) 2
Site 20, Wastewater Collection Basins
Site 16, FSA 3
Site 9, Fire Department Training Area (FDTA) 6
Site 6, FDTA 3
Site 7, FDTA 4
Site 18, Solvent Lines
Site 10, Chrome Pit 1
Site 5, FDTA 2
Site 14, FSA 1
East Parking Lot Monitor Wells
Fuel Storage Tank
Lake Worth Monitor Wells
Zone 1 (Site 13, Die Pits; Site 11, Chrome Pit 2; Site 8, FDTA 5)
Ambient Monitoring (HM-29, 52, 54, 56, 57, 58, 59, 61, 64; P-5u, 5m, 10u, 10m, 9u, 9m)

TABLE 2-2. ANALYTICAL METHODS, DETECTION LIMITS AND NUMBER OF SAMPLES FOR PHASE II STAGE 1 INVESTIGATION AT AIR FORCE PLANT 4, TEXAS

Parameter	Method	Detection Limit	Samples	QA/QC[b]	Total Samples
Chromium	EPA 218.1	50 ug/L 5 ug/g	28G 2S	3	33
Purgeable Organics	EPA 601/602 or 8010/8020	a	99G 23S 10W	47	179
Base Neutrals and Acid Extractibles	EPA 625	c	78G 4S 10W	10	102
Heavy Metals	FR, Vol 44 3 Dec 1979	d	82G 12S 10W	11	115
HC Fuels	EPA 418.1		52G 22S	8	82
Oil & Grease (IR)	EPA 413.2	100 ug/L	47G 10S	6	63
pH	EPA 150.1	±0.1 unit			
MEK	EPA 8015		5G 2S	1	8
Specific Conductance	EPA 120.1	1 umho/cm			
Xylene (AVO)	EPA 8020	c	5G 2S	1	8
SUSPECTED HAZARDOUS WASTES:					
EP Toxicity	EPA 1310	c	20G 20S	4	44
Ignitability	40 CFR 261.21	e	20S	2	22
Purgeables	EPA 624	c	30G 20S	5	55

(Continued)

TABLE 2-2. (Continued)

NOTES (Table 2-2):

a. Detection limits for Purgeable Organic Compounds shall be as specified for the compounds by EPA Methods 601/602 and 8010/8020 (soils). These methods for purgeable organic compounds require positive confirmation by a second gas chromatographic column. This must be done before reporting positive values. Second column confirmation is required when values exceed:

Benzene	0.7 ug/L
Carbon Tetrachloride	4.0 ug/L
1,2 Dichlorethane	0.1 ug/L
Methylene Chloride	4.0 ug/L
Tetrachloroethylene	4.0 ug/L
Trichloroethylene	1.0 ug/L
Vinyl Chloride	1.0 ug/L
Dichlorobenzene isomers	Sum greater than 10 ug/L
Any other organic	Greater than 10 ug/L.

Retention time on both columns must match before reporting positive value. If there is no match, values are considered as interference.

If questions are encountered about certain contaminants, you may be asked to show both chromatograms used to rule out possible interference.

b. Includes 10% QA/QC for all samples and 25% second column analyses on EPA Methods 601, 602, 8010, and 8020.

c. Detection limits specified by the EPA or Standard method.

d. Heavy Metals:

Metal	ug/L of Leaching Solution
As	10
Ba	200
Cd	10
Cr	50
Pb	20
Hg	1
Se	10
Ag	10

e. Determined if sample is ignitable at 140°F or below. If so, it is a hazardous waste.

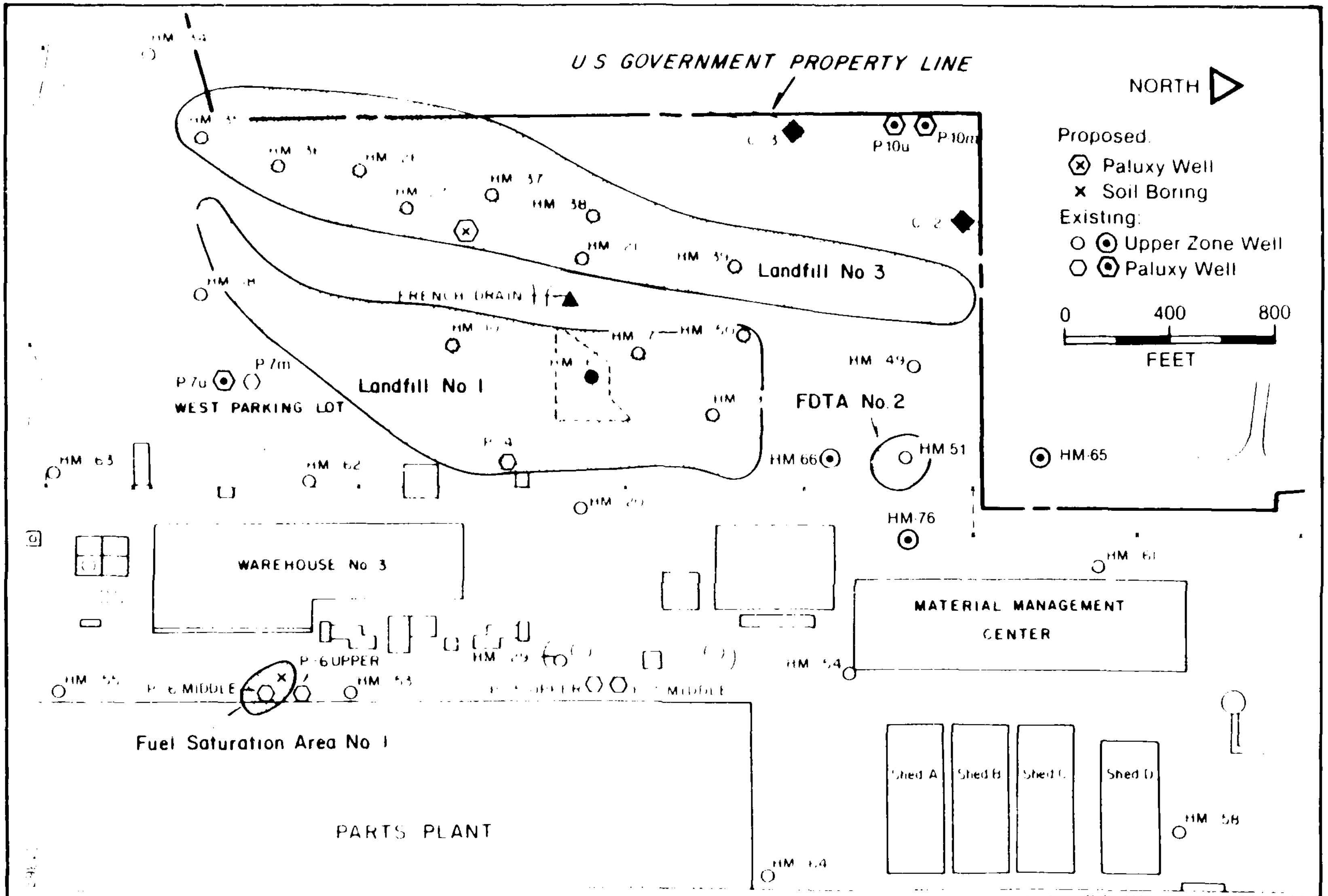

Figure 2-1. Phase II Stage 1 Activities at Landfills 1, 3; Fuel Saturation Area 1; and FDTA 2.

appear to be restricted to Federal property due to geological and hydrological conditions beneath the plant.

IRP Phase II Activities

Continued monitoring of the existing Upper Zone and Paluxy monitor wells, French drains, the drain pipe, and surface water will be carried out in the investigation. This information, in conjunction with the other data developed at neighboring sites, will be used to develop plans for remedial actions or recommendations for additional monitoring actions.

Ground-water samples will be collected at the following existing wells. HM-7, 10, 18, 20, 62, 63, P-4, P-7m and P-7u. In addition, samples will be collected from the French drains 1 and 2, and the drain pipe. Surface water samples will be collected at the creek seep as well as creek locations C-1, 2, 3, 4, 5 and St-5 outfall. All samples will be analyzed for volatile organic compounds, base/neutral compounds, and heavy metals.

Also, the effectiveness of the recently installed liners in the storm drain at ST-5 outfall in preventing release of contaminants to the creeks will be determined on the basis on water-quality data from the creek.

2.2 Site No. 3, Landfill No. 3

This site (Figure 2-1) reportedly was used for disposal of miscellaneous wastes from about 1942 to 1945, including hazardous liquid wastes consisting of mixed oils and solvents. One or more pits were present in this area during the 1940s and were used for holding and burning some of the liquid wastes. Other wastes are suspected to have been disposed of on the ground and then buried. Water quality analyses from two upper zone monitoring wells (HM-26 and HM-27) have indicated the presence of elevated levels of volatile organic compounds in the ground water.

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IRP Phase II Activities

A geophysical program, consisting of electromagnetic profiling will be conducted to provide a rapid survey of the landfill area in order to determine the horizontal extent and zones of greatest contamination, if present. The geophysical data will be evaluated to determine if a soil boring program will be appropriate in latter stages of Phase II.

A monitor well will be installed in the upper Paluxy member to a maximum depth of 150 feet near the southern (downgradient) boundary of Landfill 3. One ground-water sample will be collected and analyzed for volatile organic compounds, base/neutral compounds and heavy metals.

Additional ground water samples will be collected at the following wells: HM-39, 38, 21, 37, 27, 26, 36, 35, and 34. Each of these samples will be analyzed for volatile organic compounds, base/neutral compounds, and heavy metals.

2.3 Site No. 12, Chrome Pit No. 3

Chromate and other chemical wastes were disposed of at this site (Figure 2-2) from about 1957 until 1973. Barium chromate sludge, dilute metals solutions, and drums of unidentified liquids were disposed of in this pit.

Soil borings and shallow ground-water sampling conducted in 1982 confirmed contamination at this site. About 8,900 cubic yards of contaminated soil were excavated during December 1983 and January 1984. Soil testing conducted during the excavation indicated that the most contaminated soils were removed from the site.

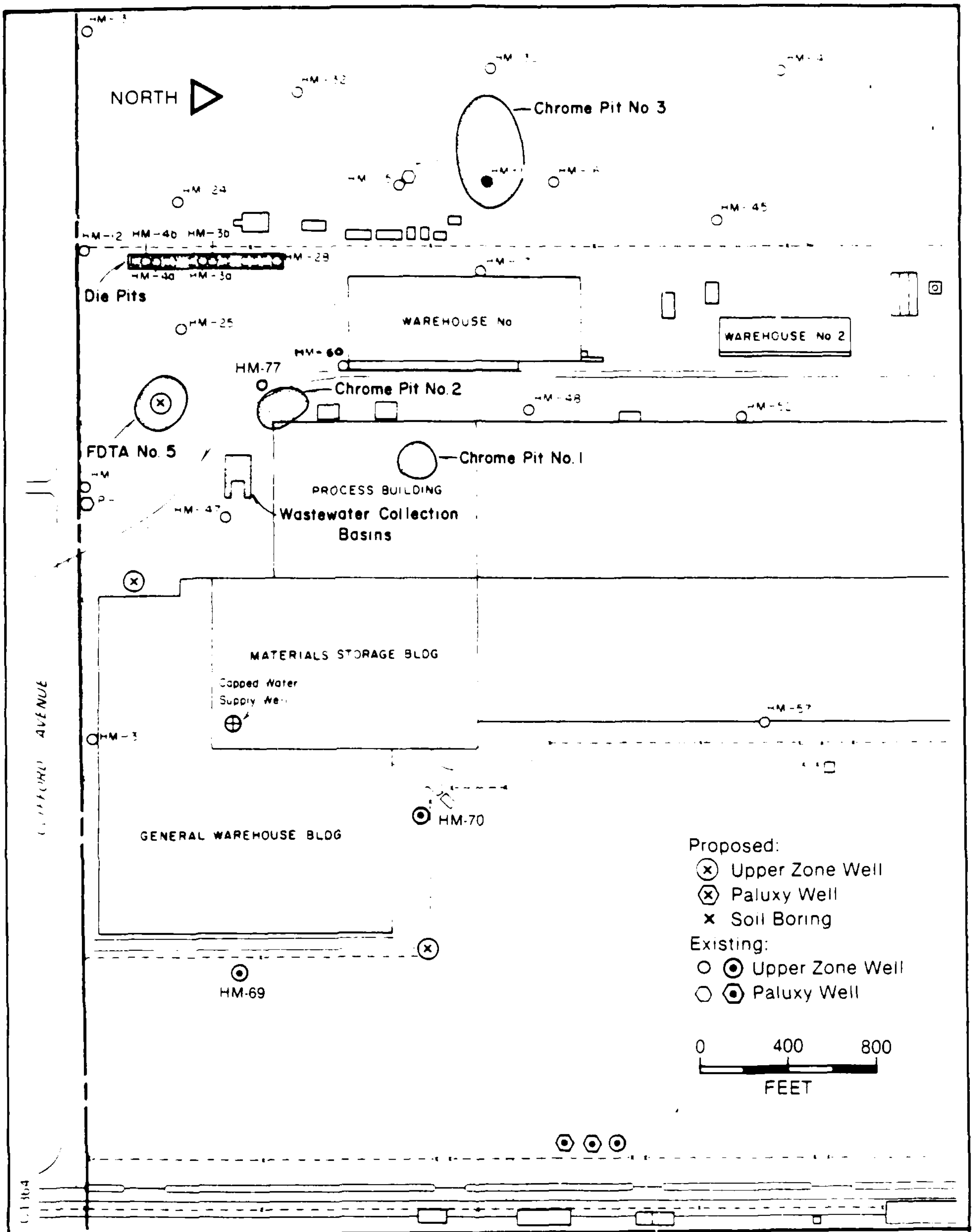

Figure 2-2. Phase II Stage 1 Activities at Chrome Pit 1, 2, 3; FDTA 5; Die Pits; and Wastewater Collection Basins.

IRP Phase II Activities

Continued post-closure monitoring will be conducted at wells HM-30, 16, 15, 45, 17, 32, 13, 41, and P-2. Each sample from these wells will be analyzed for volatile organic compounds, base/neutral comounds and heavy metals.

2.4 Site No. 17, Former Fuel Storage Site

This site (Figure 2-3) was the former location of a 100,000-gallon above-ground JP-4 storage tank from the early 1940s until it was relocated in 1962. Sampling at this site in 1982 confirmed that soils and upper zone ground water are contaminated by fuels and other organic compounds.

IRP Phase II Activities

Actions at this site will include sampling HM-8 and HM-14 and analysis of ground water for hydrocarbon fuels. Well HM-8 will be inspected to determine if a lens of jet fuel is on top of the water table. If a fuel lens is observed, a measurement of its thickness will be made.

One additional ground water monitoring well will be installed in the upper zone to a maximum depth of 40 feet. The screen will be positioned at the water table. One water and three soil samples will be analyzed for hydrocarbon fuels.

If fuel is detected in the upper zone ground water, several alternatives for instituting remedial actions will be identified and briefly described.

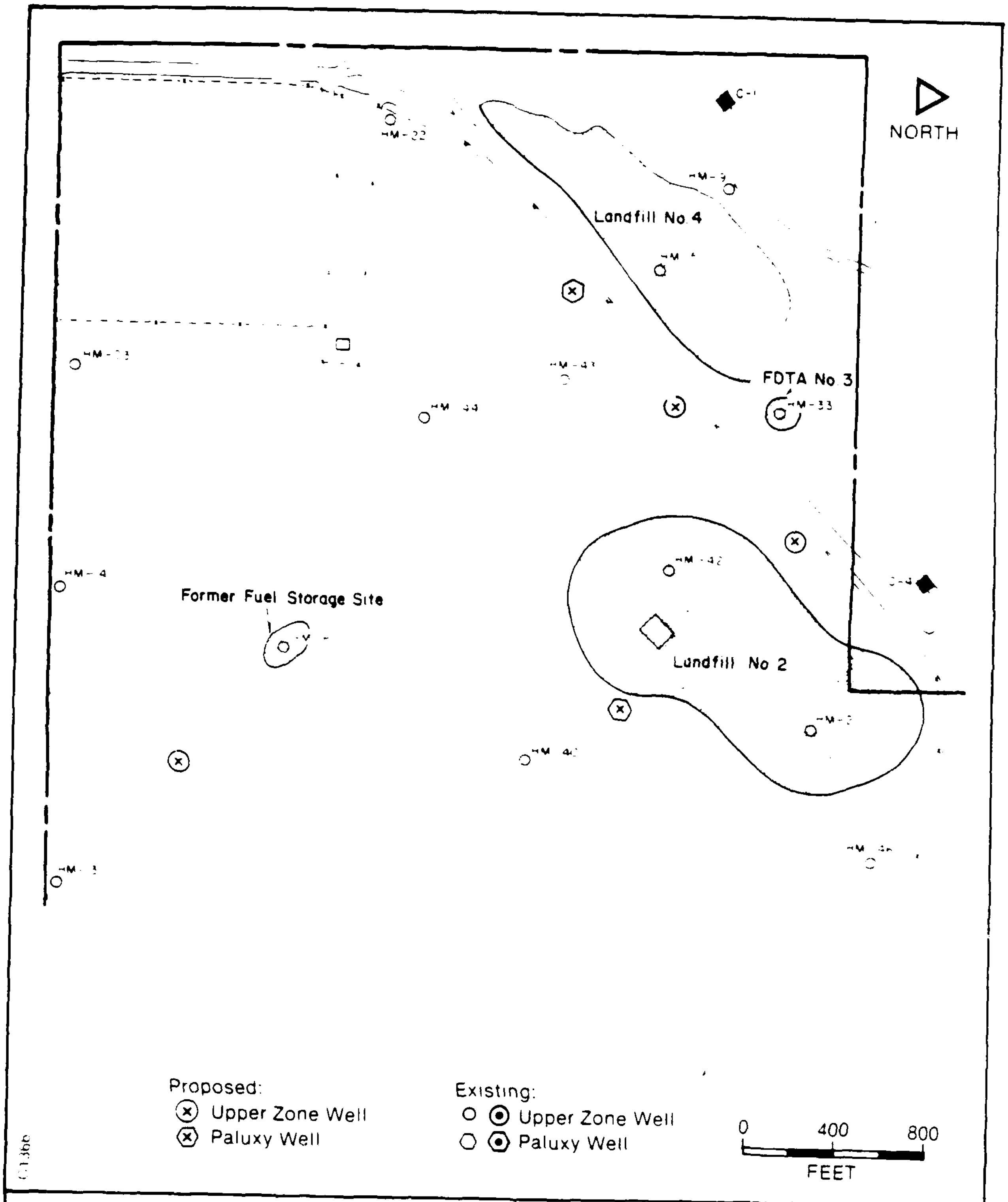

Figure 2-3. Phase II Stage 1 Activities at Former Fuel Storage Site; Landfills 2, 4.

2.5 Site No. 2, Landfill No. 2

The site originally consisted of some low areas and a livestock watering hole. The majority of this site was reportedly filled with construction rubble, plaster, and fill dirt during the early 1940s. However, some activity at the stock watering hole at this site is evident on aerial photographs up until at least 1962. This area was reportedly used for disposal of lumber and tires and was assumed to be periodically burned. There were no verbal reports of hazardous substances being deposited at this site; however, it is likely that small quantities of wastes were infrequently disposed of at this site.

IRP Phase II Activities

A geophysical survey, consisting of electromagnetic profiling, will be conducted to determine the horizontal extent and zones of greatest subsurface contamination, if present. The geophysical data will be evaluated to determine if a soil boring program would be appropriate.

One downgradient Paluxy monitor well will be installed to a maximum depth of 150 feet. The well will be screened in the upper sand unit. Ground-water samples will be collected and analyzed for volatile organic compounds, base/neutral compounds and heavy metals. Ground-water samples will also be collected at wells HM-2, 22, 40, 42, 43, 44, 46 and analyzed for volatile organic compounds, base/neutral compounds and heavy metals.

2.6 Site No. 4, Landfill No. 4

Landfill No. 4 (Figure 2-3) was reportedly used for disposal of clean construction rubble from its start in about 1956 until its closure in the early 1980s. Aerial photographs of the site and at least one memo dated 1973 indicate that other types of wastes may have been disposed of at this site from the time of closure of Landfill No. 1 (1966) until at least 1973.

Based on this evidence, small quantities of hazardous wastes (solvents, oils, fuels, thinners, etc.) are thought to be present in this landfill. Water samples from upper zone monitoring wells HM-5 and HM-9 have been found to contain volatile organic compounds and other organic compounds. These data are considered to be indirect evidence of migration at this site. However, recent data from these wells have been negative for these compounds.

IRP Phase II Activities

One upper zone well will be installed to a maximum depth of 40 feet. One water and two soil samples will be collected and analyzed for volatile organic compounds, base/neutral compounds and heavy metals.

One Paluxy monitor well will be installed downgradient to a maximum depth of 150 feet. The well will be screened in the upper member. One ground-water sample will be collected and analyzed for volatile organic compounds, base/neutral and heavy metals. Ground-water samples will also be collected at wells HM-5 and HM-9, and analyzed for volatile organic compounds, base/neutral and heavy metals.

2.7 Zone 1

Three sites have been combined into one zone, shown on Figure 2-2. Descriptions of Phase II Stage 1 activities are given below.

Site No. 13, Die Pits

These pits were used for disposal of chromate sludges, metal solutions, and other chemical wastes until 1962, when the site was graded and the entire die yard was paved. The site of the original pits was excavated in 1983-84. Soils from other parts of the die yard were not analyzed at that time.

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Site No. 11, Chrome Pit No. 2

Miscellaneous liquid and solid wastes, in addition to chromate solutions, were reported disposed of at this site. The actual location of this site could not be accurately confirmed during the Phase I (Records Search) investigation.

Site No. 8, FDTA No. 5

This site consisted of a shallow pit in which waste fuels, oils, or chemicals were deposited for training exercises. This site is located in the die yard area south of Warehouse 1 and has been graded and paved. Groundwater analyses indicated elevated levels of organic compounds at this site.

IRP Activities

Ground-water samples will be collected at the following existing wells adjacent to the excavated die pits: HM-11, 12, 24, 25, 28 60, 77, and P-1. Each of these samples will be analyzed for volatile organic compounds, base/neutral compounds and heavy metals. Additionally, ground-water samples from well HM-77 will be analyzed for hydrocarbon fuels and oil & grease.

An upper zone monitor well will be installed to a depth of 40 feet and located in the estimated center of FDTA 5. One water sample and two soil samples will be collected and analyzed for volatile organic compounds, base/neutral compounds and heavy metals.

2.8 Site No. 20, Wastewater Collection Basins

Two concrete-lin d waste basins (Figure 2-2) with approximately 85,000 gallon capacity each are used to collect and settle suspended solids from chemical wastewaters. The basins have been in use since approximately 1966. Phase I investigation determined that several spills of vapor degreaser

from tanks in the Process Building have occurred. Spilled liquids may have flowed to the basin via floor drains in the Process Building. Field confirmation studies described below will be conducted to determine if underlying soil and upper zone ground water have been affected.

IRP Phase II Activities

One Upper Zone monitor well will be installed to a maximum depth of 40 feet directly north of the basins near the Process Building. One water and two soil samples will be collected and analyzed for volatile organic compounds, oil and grease, hydrocarbon fuels, and heavy metals.

Ground-water samples will also be collected from existing wells HM-31, 47, 69 and 70. Each sample shall be analyzed for volatile organic compounds, oil and grease, hydrocarbon fuels, and heavy metals.

The location and depth of the buried sanitary and industrial waste lines will be determined as part of the effort to locate the new monitor well. Also, the need for sampling soil along their length will be determined based on the results of water and soil analyses.

2.9 Site No. 16, Fuel Saturation Area No. 3

Soils at this site (Figure 2-4) became saturated by fuels due to leaks in buried fuel lines from the mid-1970s until the early 1980s.

IRP Phase II Activities

One water sample will be collected from monitor well HM-78 and analyzed for hydrocarbon fuels and volatile organic compounds. This well will be inspected for the existence of a fuel lens. If fuel is present, the thickness of the fuel lens will be measured.

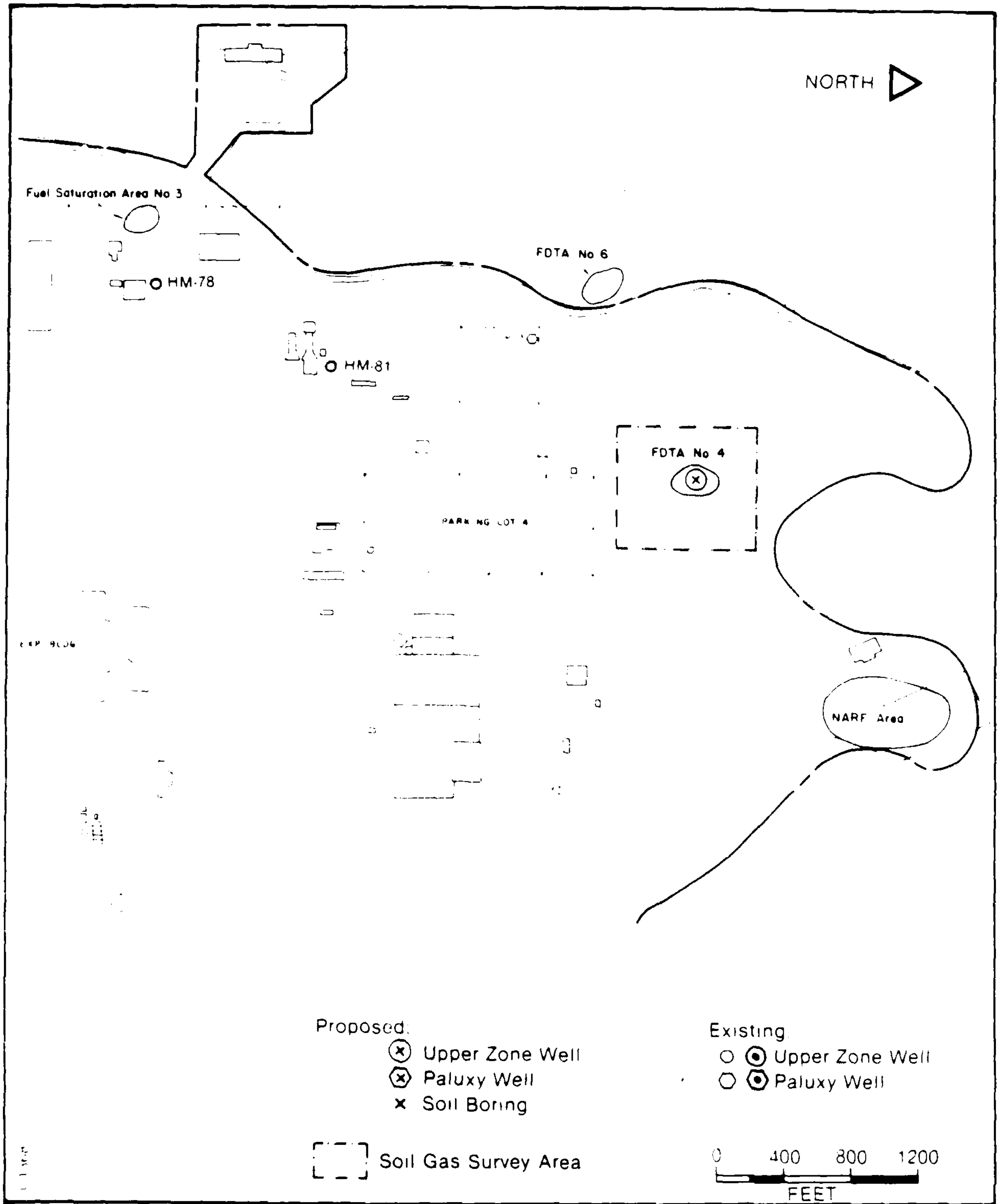

Figure 2-4. Phase II Stage 1 Activities at Fuel Saturation Area 3; FDTA 6, and FDTA 4.

A review of on-going studies will be conducted to determine the areal extent of fuel saturation. This work will also be coordinated with the Remedial Action Program contractor (Fluor).

2.10 Site No. 9, FDTA No. 6

Before 1970, training exercises were conducted two times per year at this site (Figure 2-4); after 1970, exercises were conducted at monthly intervals. Approximately 250 gallons of waste fuels and oils were reportedly used for each exercise. In addition, it is suspected that larger quantities of contaminated fuels and oils were deposited in the FDTA between exercises.

In 1983 FDTA No. 6 was excavated and removed as part of the hazardous waste remedial actions being conducted at AF Plant 4. No monitor wells have been installed at this site due to the absence of upper zone (alluvium) deposits. However, well P-3 is located southeast of the site and will be used as a sampling point during the investigation.

IRP Phase II Activities

A series of hand augered borings will be made at this site. Six soil samples will be collected and submitted for analysis on the basis of color, texture and odor. Each sample will be analyzed for oil and grease, heavy metals, hydrocarbon fuels, and volatile organic compounds.

2.11 Site No. 6, FDTA No. 3

Training exercises at this site (Figure 2-3) used about 250 gallons per exercise of discarded fuels and oils. This site is not readily visible on historical aerial photographs, so its location and current condition could not be accurately determined.

Monitor well HM-33 is at the suspected location of FDTA No. 3, and was initially sampled in August 1984. Toluene was detected at concentrations of 8 ug/l, but no other priority organic compounds were found.

IRP Phase II Activities

One ground-water sample will be collected from existing well HM-33 and analyzed for oil and grease, volatile organic compounds, and hydrocarbon fuels. This well will also be inspected for the occurrence of a fuel lens. In addition, one ground-water monitor well will be constructed in the upper zone, with a water sample analyzed for volatile organic compounds, hydrocarbon fuels, and oil and grease.

2.12 Site No. 7, FDTA No. 4

Fire training activities used about 250 gallons per exercise of discarded fuels and oils. This site is not readily visible on historical aerial photographs, so that its location (estimated on Figure 2-4) and current condition is not accurately known. This area has recently received clean fill material from a foundation excavation at the Administration Building.

IRP Phase II Activities

A soil gas survey will be conducted in and around the suspected location of the site. The goal of the survey is to accurately locate the fire training area on the basis of soil gas measurements. If the results of the survey indicate ground-water monitoring would be appropriate, one ground-water monitor well will be installed to a maximum depth of 40 feet. A sample of ground water will be collected and analyzed for volatile organic compounds, oil and grease, and hydrocarbon fuels. The well will be inspected for a fuel lens; if a lens exists, its thickness will be measured. All activities at this site will be coordinted with GD personnel regarding the placement of fill material.

2.13 Site No. 18, Solvent Lines

These lines (Figure 2-5) reportedly leaked during the 1940s before they were drained, capped, and abandoned-in-place in 1944. The actual locations of the leaks could not be determined based on interviews. The contents of these solvent lines reportedly included xylene, methyl ethyl ketone (MEK), and kerosene.

IRP Activities

One upper zone ground-water monitor well will be installed to a depth of 40 feet at a location complementary to the existing well network around these lines. Two soil samples will be collected and analyzed for xylene, oil and grease, and MEK. A ground-water sample will be collected and analyzed for oil and grease, xylene, and MEK.

Ground-water samples from wells HM-72, -73, -74, and -75 will be analyzed for xylene, oil and grease, and MEK.

2.14 Site No. 10, Chrome Pit No. 1

It is suspected that miscellaneous liquid and solid chemical wastes, including chrome wastes, were disposed of at this site (Figure 2-2). The actual location of this site is believed to be somewhere beneath the Process Building, but could not be accurately confirmed based on interviews or aerial photographs. No monitor wells exist in the immediate vicinity of the chrome pit.

IRP Phase II Activities

One upper zone ground-water monitor well will be installed to a maximum depth of 40 feet. Because it is not feasible to conduct drilling

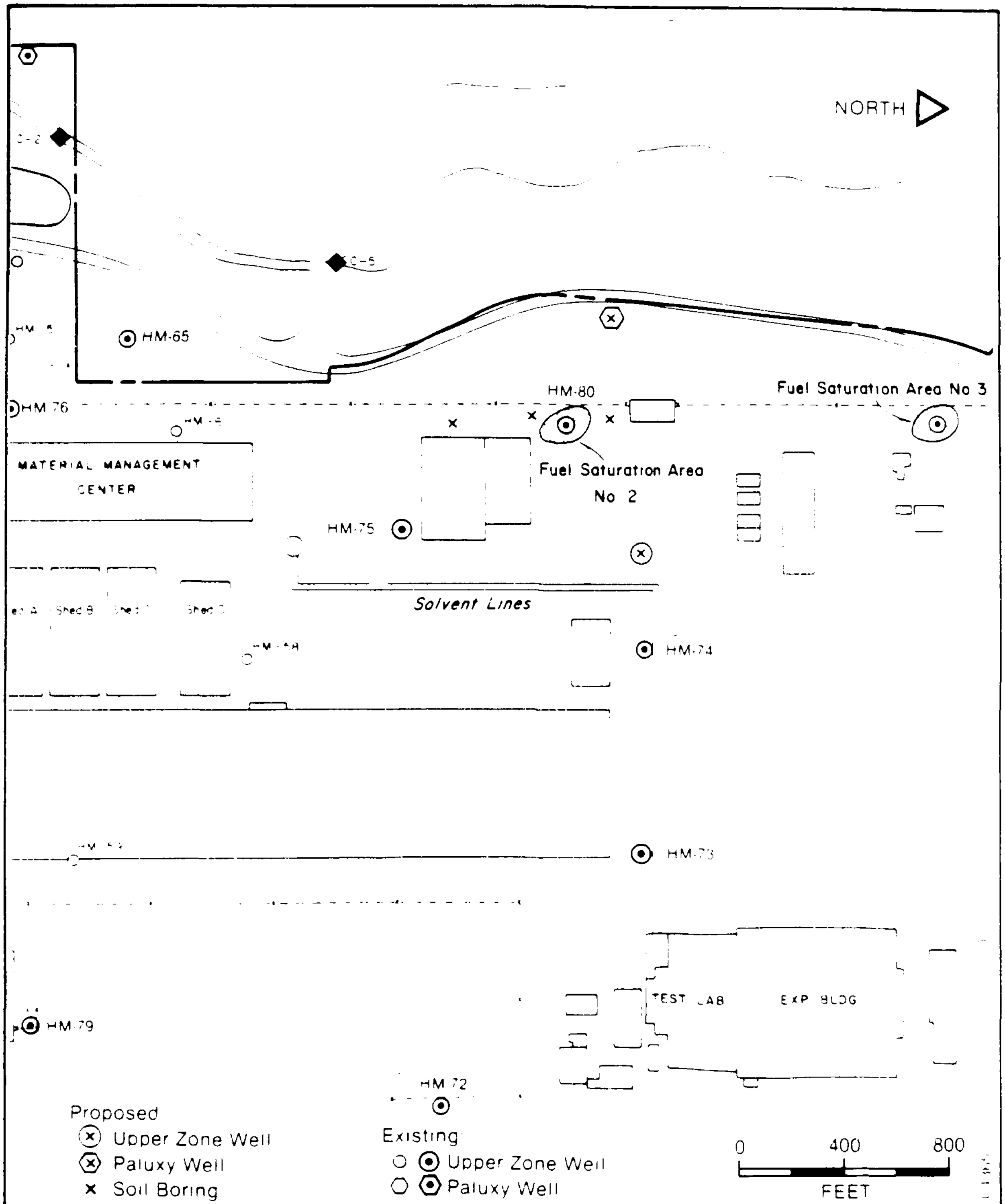

Figure 2-5. Phase II Stage 1 Activities at the Solvent Lines, Fuel Saturation Area 2, and Lake Worth Wells.

within the Process Building, the monitor well will be located in a downgradient area outside the building and in an area that will complement the existing well network. Two soil samples will be collected and analyzed for volatile organic compounds and chromium. One water sample will be collected and analyzed for volatile organic compounds and chromium.

One ground-water sample will be collected from existing well HM-48 and two existing wells that will be specified in the field. These samples will be analyzed for volatile organic compounds and chromium.

2.15 Site 15, Fuel Saturation Area No. 2

Soils at this site (Figure 2-5) became saturated by fuels due to leaks in buried fuel lines between the 1970s and early 1980s.

IRP Activities

One water sample will be collected from the existing monitor well HM-80 and analyzed for hydrocarbon fuels and volatile organic compounds. The well will also be inspected for the occurrence and thickness of a fuel lens.

Three boreholes will be drilled to an average depth of 30 feet (total of 90 linear feet) along the length of the buried fuel line. Soil samples will be collected from each borehole, and three samples will be analyzed on the basis of color, odor, or OVA analysis for hydrocarbon fuels and volatile organic compounds.

If fuel saturation is found to occur at this site, several remedial action alternatives will be identified and briefly described.

2.16 Site No. 5, FDTA No. 2

Fire training exercises were held about twice per year at this site (Figure 2-1); however, disposal of waste oils and fuels and uncontrolled burns may have been more frequent. This site is currently located under the pavement in the west employee parking area.

IRP Phase II Activities

A geophysical profile (electromagnetic) will be conducted of the area around the site to determine the extent of hydrocarbons in ground water. Ground-water samples will be collected at monitor wells HM-19, 49, 50, 51, 65, 66, and 76. The samples will be analyzed for volatile organic compounds, oil and grease, and hydrocarbon fuels.

2.17 Site No. 14, Fuel Saturation Area 1

Soils at this site, located just west of the Parts Plant (Figure 2-1), became saturated by fuels due to leaks in buried fuel lines from the mid-1970s to the early 1980s. This site is the subject of Phase IV Remedial Action Planning by Fluor.

IRP Phase II Activities

One boring will be made in the area of fuel saturation. The boring will extent at least two feet below the water table to a maximum depth of 40 feet. Two soil samples and one water sample will be collected from the borehole and will be analyzed for hydrocarbon fuels.

In addition, ground-water samples will be collected from wells HM-53, 55, P-6m, 6u, and analyzed for hydrocarbon fuels. The monitor wells will be inspected for the presence (and thickness) of a fuel lens. All Phase

II activities will be coordinated with the on-going remedial action planning conducted by Fluor.

2.18 Lake Worth Monitor Wells

One ground-water monitor well will be installed along the northern area of AF Plant 4 that borders Lake Worth (Figure 2-5). The purpose of installing a monitor well at this location is to determine the occurrence and character of ground water in the vicinity of Lake Worth. The well shall will be completed into the upper member of the Paluxy Formation. It is expected that the well will be on the order of 50 feet deep.

Two water samples will be collected one month apart at the new well. Each sample shall be analyzed for volatile organic compounds, base/neutral compounds, and heavy metals.

2.19 Ambient Monitoring

Several wells installed at the AF Plant 4 are not associated with a particular waste disposal site or suspected spill area. Ground water from these wells will be sampled and analyzed along with the other wells in order to provide a complete view of ground-water quality at Plant 4. The wells to be sampled include: HM-29, 52, ~~53~~, 56, 57, 58, 59, 61, 64, 79, 81; P-5u, 5m 10u, 9u, 9m, and ~~four~~ wells that have not yet been specified. These four wells may be the Paluxy wells installed by the Corps of Engineers at the southern boundary of Plant 4 or the new monitor wells installed in the vicinity of Building 197. The selection of wells to be sampled will be made prior to the start-up of field activities. Samples will be analyzed for volatile organic compounds, base/neutral compounds, oil and grease, hydrocarbon fuels, heavy metals, and chromium.

2.20 East Parking Lot

Five wells located in the vicinity of the East Parking Lot will be sampled during the Phase II Stage 1 investigation. These wells are: HM-68, 71, 82; P-8u, and 8m. Samples will be analyzed for volatile organic compounds, base/neutral compounds, oil and grease, hydrocarbon fuels, heavy metals, and chromium.

2.21 White Settlement Ground-Water Pumping Effects

The influence of pumping by White Settlement on ground water flow in the Paluxy aquifer at Plant 4 will be investigated. Pumping of ground-water from the City of White Settlement wells produces a potentiometric low which influences the flow of ground-water in the Paluxy aquifer in a southerly direction. The effect of ground-water withdrawals at White Settlement is unknown at the southern boundary of Plant 4 where contaminated ground-water has been detected in the upper zone.

The investigation will include an examination of pumping records and projected water demands for water by the City of White Settlement, historical records on Paluxy wells at Plant 4, hydrogeologic and water quality data developed during ground water investigations conducted by General Dynamics, as well as geologic data on the thickness, character, and extent of the Goodland Limestone and Walnut Formation.

The impact on the above parameters on ground-water flow in the Paluxy near AF Plant 4 will be evaluated. Also, the direction of ground-water flow in the Paluxy and the zone of influence of the White Settlement wells will be determined.

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3.0 FIELD PROGRAM COORDINATION

The field program at AF Plant 4 will consist of the activities described in this Technical Operations Plan. Input from General Dynamics has been solicited during a pre-field activities visit to finalize the eventual deployment of field equipment. The information from General Dynamics incorporates the latest maintenance, training, utility activities, and subcontractor requirements to ensure that no scheduling and/or space conflicts will occur.

The following sections briefly identify and describe the plans that will guide the conduct of the field program.

3.1 Health and Safety Plan

Safety is an integral part of any field investigation. This is because of the inherent dangers associated with heavy drilling equipment and the potential to encounter contaminated soils and/or ground water. Therefore, a Health and Safety Plan has been developed for this project that will be integrated into the field activities. The Health and Safety Plan is provided in Appendix B.

3.2 Sampling Quality Control (QC) Plan

A QC plan has been developed in order to ensure sample representativeness and preservation until the time of laboratory analysis. The QC plan directs how field samples will be obtained, preserved and controlled. The will ensure that the integrity of the sample is maintained and that no contamination or cross-contamination will occur. The QC plan is provided in Appendix C.

3.3 Subcontractor Requirements

Several subcontractors with specialized capabilities are required to execute the field program. The categories of field work are identified as follows where the parentheses denote the degree of projected field support facility requirements. The field work will consist of:

- Soil Borings and Monitor Well Installation (maximum support)
- Geophysical Surveys (moderate support)
- Soil Gas Survey (moderate support)
- Surveying (minimal support)

The following project or activity areas will be identified by General Dynamics prior to the initiation of the drilling activities:

- Drilling equipment and materials staging area,
- Decontamination/wash rack areas,
- Monitor well flush completion boxes and any special cementing requirements,
- Sample storage area,
- Medical emergency centers,
- Holding area for suspected contaminated soils, and
- Potable water supply access.

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4.0 OPERATION OF FIELD EQUIPMENT

During this investigation a number of instruments will be required to support on-site activities. These will be used to provide field data on the occurrence and character of subsurface vapors, surface water, and ground water. One purpose of these measurements is to ensure early warning to field personnel of potential contaminant exposures. Another purpose of this monitoring is to document subsurface conditions. The equipment to be used will be for air and vapor measurements and soil and water measurements.

4.1 Air Monitoring Equipment

Two types of air monitoring equipment will be used. The first type will be direct, continuous air sampling equipment. This will be accomplished either by a photoionization detector (PID) such as an HNU, AID, or by a flame ionization detector (FID) such as an organic vapor analyzer (OVA) that provides a measure of total hydrocarbons, relative to a specific known gas. The HNU and AID are calibrated to benzene and the OVA is calibrated to methane. The second type is Draeger tubes that respond to a variety of chemical compounds for real time detection and identification.

Measurements will be made both upward and downward of the site; in the breathing zone above the borehole; and over fresh, returned cuttings from the borehole. Draeger tubes will be used for periodic organic analyses, as determined by the supervising geologist.

HNU, AID or OVA

Prior to initial drilling activities, the air monitoring equipment will be calibrated. From 3 to 5 calibration gases of different concentrations will be used to check instrument response linearity. The types of gases for the instrument are noted above. A plot of known concentrations vs. instrument readings is graphed to determine linearity. A perfect straight line has a

correlation coefficient equal to one (1). If the correlation coefficient is greater than 0.9950, the instrument response is considered to be linear and the instrument is ready for field use. When drilling activities have been completed another multipoint calibration test is performed to note if any deviation exists. If deviation is noted then the field measurements are adjusted accordingly. Should the correlation coefficient at the end of the drilling activities be less than 0.9950, although unlikely, the field data become less accurate.

During the operation of air monitoring equipment, the probe should be kept free of solids or liquids. The OVA filter will also require cleaning with dionized water on a weekly basis.

Draeger Pump

When a Draeger pump and associated detection tubes are used, the pump needs to be in proper working order. This can be determined by placing an unopened tube into the pump portal and compressing the bellows. If the bellows remain compressed for at least 10 minutes, the pump is in good working order.

4.2 Physical Properties Instrumentation

For the field analysis of water and soil samples, the following equipment will be used:

- o pH and Conductivity Meter - The pH meter is calibrated using pH 4, 7 and 10 laboratory buffer solutions. The conductivity meter is calibrated prior to initial field work using an 0.01 Molar KCl solution which produces a 1413 umhos/cm reading at 25°C. It is important to keep the pH and buffer solution in the detection cup when not in use.

Measurements of pH will be taken on water purged from wells prior to sampling (to ensure conditions representative of the formation) and on all ground-water samples. A Myron L pDS Model EP10/DS pH/conductivity meter (or equivalent) will be used for the field analysis. The pH meter will be calibrated daily, using pH buffer solutions of 4, 7, and 10. The users' manual will be available to field personnel.

Conductivity measurements will be taken on purge water and all ground-water samples using the Myron pH/conductivity meter described above. A standard solution of known conductivity (i.e., 1413 umhos/cm @ 25°C) will be made available for daily calibration. The users' manual for the electrical conductivity meter will be available to field personnel.

- <u>Mercury Thermometer</u> - Temperature measurements will be taken on all groundwater and surface-water samples using a mercury-in-glass thermometer.

- <u>Water Level Probe</u> - A fisher M-Scope or comparable electric line will be used to determine the static water level in each well to the nearest 0.01 foot. Measurements will be made on a minimum of two occasions: following development and prior to sampling. Measurements will be taken as feet below the top of casing and reported as elevations relative to mean sea level (MSL). The probe will be calibrated with a steel surveyor's type at the beginning of measurement activities.

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5.0 FIELD TEAM ORGANIZATION AND RESPONSIBILITIES

The following paragraphs describe the project team organization, responsibilities of key personnel, and personnel training to be included in the Phase II Stage 1 IRP investigation of Air Force Plant 4.

5.1 Organization

The Radian project team for the Phase II study includes the following key personnel:

- o Project Director
- o Supervising Geologists
- o Corporate Safety Officer.

The activities of the Radian field team will be coordinated with OEHL and Air Force Plant 4 (General Dynamics) personnel principally by the Project Director. All field activities will be conducted under the supervision of a Radian hydrogeologist. The Corporate Safety Officer will approve the Health and Safety Plan for field activities to be conducted at the site.

Subcontractors will be used to provide crews and equipment for geophysical surveys, drilling, final well development, drums for contaminated cuttings, and surveying. One individual or firm may perform more than one of the functions listed above.

5.2 Responsibilities

Specific responsibilities of key project personnel are summarized below:

Project Director - The Project Director (PD) is responsible for assuring that all activities are conducted in accordance with the

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Technical Operations Plan. The PD also provides technical coordination and interfacing with the OEHL technical monitor. He will monitor budget and schedule and assure the availability of necessary equipment and subcontractors. He will participate in reporting and have primary responsibility for the technical quality of all products. The Project Director may also be a supervising geologist.

Supervising Geologists - An American Institute of Professional Geologists (AIPG) registered geologist is responsible for the overall direction of drilling activities and installation of test wells, including soil/formation sampling, logging and initial well development and supervising another on-site geologist. He will assure that field activities are conducted in accordance with the Technical Operations Plan, the Health and Safety Plan, and all requirements of applicable drilling and sampling methodologies. He will also be responsible for monitoring of exposure levels to organic contaminants throughout drilling activities.

Corporate Safety Officer - The Corporate Safety Officer will review and/or develop a Health and Safety Plan tailored to the specific needs of the investigation. In consultation with the Project Director, he will develop guidance for assuring an adequate level of personal protection from anticipated potential hazards for all field personnel.

5.3 Training

Field personnel will be adequately trained with regard to hazardous waste site experience, use of personal protective equipment, and emergency response procedures.

All Radian field personnel will receive the Air Force Plant 4 IRP Phase II Stage 1 Technical Operations Plan (TOP), in a timely manner to allow

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for a sufficient review period. The drilling subcontractor will receive information from the TOP pertaining to their operations and the Health and Safety Plan. Prior to the initiation of field operations, a field staff orientation and briefing will be held to acquaint personnel with the site and the operation of any unusual field equipment, and to assign field responsibilities.

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6.0 SITE INVESTIGATIONS

The overall objective of the Air Force Plant 4 Phase II investigation is to define the presence, magnitude, direction, rate and extent of movement of any identified contaminants. This activity will assist in the eventual identification of remedial alternatives. To support this task, three geophysical surveys and one soil gas survey will be conducted and 20 soil borings and 12 monitor wells will be installed. Drilling locations will be selected in the field by the Supervising Geologist, in accordance with guidance contained in the Statement of Work and consultation with OEHL and Air Force Plant 4 (General Dynamics) personnel. The exact locations will be finalized during the on-base utility clearances at the outset of the field activities.

6.1 Geophysical Surveys

Geophysical surveys, consisting of electromagnetic profiling, will be conducted at three sites at AF Plant 4. The equipment to be used on the survey will be the Geonics EM 31 and EM 34-3, or equivalent. The equipment will be used according to manufacturer's specifications, maintained in good working order and calibrated regularly. At each station the readings will be manually recorded. The data will be plotted as profiles along survey lines or contoured. Through daily plotting of the data the crew chief will maintain quality control and, based on observations, recommend necessary changes in measurement density or line orientation. The data at each site will be contoured, and boundaries of landfills, presence of waste trenches, and leachate plumes will be indicated on these contour maps. By making measurements with both the EM 31 and EM 34-3, the conductivity stratification as a function of depth may be derives, if possible.

It is not anticipated that the performance of the geophysical surveys will require special personnel protection or safety precautions.

6.2 Soil Gas Survey

A soil gas survey will be conducted in the suspected area of fire training area No. 4. The soil gas investigation will determine if volatile organic contaminants exist so that monitor well installation plans can be made.

Samples are collected by hydraulically driving a rig-mounted hollow probe into the ground and evacuating a small amount (10 to 20 liters) of air. A sample is collected with a syringe during the evacuation step by inserting the needle through the evacuation line and drawing a sample from the air stream. The sample size may range from 1 ul to 1 ml depending on the requirements of the analysis. The sample is analyzed immediately on-site in a mobile analytical van equipped with a gas chromatograph. Probes are typically driven 3 to 20 feet into the ground. Most soil air or gas plume mapping operations are performed with probes driven to a depth of 5 feet. A typical operation of sampling to a depth of 5 feet, soil gas analysis, and probe removal takes about 20 minutes. Typically, 26 probes will be measured in a 10 hour day.

A subcontractor under Radian supervision will conduct the soil gas survey. Only one firm is known to have the ground probe capabilities noted above which may necessitate a sole source subcontract. Appropriate justification for sole sourcing will be provided if no other qualified subcontractors are found during the competitive bid process.

6.3 Drilling and Sampling

The soil boring and sampling, and monitor well construction operations will be conducted by a subcontractor under the direct supervision of a Radian hydrogeologist.

Well drilling will be accomplished by hollow-stem auger in the upper zone (alluvium) and air rotary methods will be used for drilling into the

Paluxy Formation. Geologic samples will be collected at five-foot intervals during drilling or where significant changes in lithology occur. Samples will be collected through hollow-stem augers with the use of a Shelby-tube or split-spoon sampler in accordance with ASTM Methods D-1587 and D-1586. Formation samples will be described by the supervising geologist using common geological descriptions for unconsolidated formations (American Geological Institute and ASTM-D-2488-69). Special note will be made of observed discoloration, odors and organic vapor readings suggesting soil/formation contamination. Soil density will be approximated by recording the number of blows necessary for the split spoon to penetrate each six inches of soil. Grab samples from shallow depths may be collected from the auger flights where conditions warrant. All samples collected during the drilling of the monitor wells will be described, logged and containerized. Well logs and completion summaries will be included in the Draft and Final Reports.

During the drilling, soil samples will be screened using either a HNU, AID, or an OVA organic vapor analyzer in order to detect the presence of volatile organic contaminants. Draeger tubes may also be used during drilling to determine if soil vapors are present. Selected samples will be placed into a plastic bag or glass jar for additional contaminant screening. The volatile organic levels will be recorded on the field log. These field analyzers, although calibrated, will be useful only as indicators of the presence of significant contaminant levels. Because the instruments are sensitive to moisture, temperature change, and fluctuating ambient conditions, small concentrations above background listed on the field logs should be considered insignificant. Therefore, the organic vapor concentrations which may be detected in disturbed soil samples represent an indication of the presence of gross contamination only, and are in no way intended to represent the actual levels of contaminants present in the formations.

During field operations, log books will be maintained which describe the methods, procedures, and events concerning sample acquisition. The log books will be maintained as formal documents representing complete and

organized records of field sampling activities. The contents of the log books will include any field measurements that are taken during operations.

6.4 Waste Handling and Decontamination Procedures

All well and boring cuttings suspected of being hazardous based upon discoloration, odor, or readings from organic vapor detection instrument will be properly containerized and labeled. The general area of drilling activities will be cleaned following the completion of each well and boring. Plastic tarpaulins used to contain soil and formation cuttings will be folded such that any exposed cuttings remnants are trapped, and then placed into a drum for disposal. Purged water will be discharged to the ground in a manner that does not allow direct run-off to surface water bodies (e.g., streams, lake). If prevention of run-off cannot be assured due to the site configuration, purged water will also be drummed.When the analytical results of samples are known, the General Dynamics will oversee the appropriate disposal of containers and cuttings.

All soil/formation sampling equipment is to be decontaminated prior to use, and between sampling locations, to avoid cross contamination. The split-spoon will be washed thoroughly with a laboratory grade detergent, followed by clean water, methanol and distilled water rinses. The equipment will be allowed to dry and the solvent to evaporate before reuse.

6.5 Drilling Safety

Safety is an integral part of any drilling program. The use of large complex drilling and auger equipment creates the potential for physical injury of personnel who are also potentially exposed to adverse weather conditions. Some of the potential hazards that may be encountered during field activities are noise from rigs and jet aircraft, heat/cold stresses, lacerations and contusions as well as climbing and lifting injuries. Additionally, chemical injury may occur due to contact with contaminated materials. In

order to reduce and, wherever possible, eliminate the chance of personnel injury field procedures have been identified. These procedures are provided in Appendix B (Health and Safety Plan).

6.6 Monitor Well Construction and Completion

Hollow stem auger and air rotary techniques will be used to install the monitoring wells. The actual depth of each well will be determined in the field by the supervising Radian hydrogeologist. Specifications for monitor well completion (Upper Zone) are described in the following paragraphs, and summarized in Table 6-1.

Upper Zone Monitor Wells

Following the completion of drilling operations, each well will be screened. Two-inch diameter, schedule 40 PVC screens will be used for the upper zone (alluvium) and five-inch diameter, schedule 80 PVC will be used for the Paluxy wells and any well over 100 foot in depth. Screen lengths will be 10 foot long with 0.020 inch slots. The screen will be capped at the bottom. All connections will be threaded and flush.

The screened sections will be joined to their respective type PVC flush threaded casing. The casing will extend from the top of the screen to at least ground surface. No glues, solvents, or thread compounds will be employed during screen and casing installations. Prior to installation, the casing and screen sections will be thoroughly washed using a high-temperature, high-pressure sprayer, with potable water only.

After the casing and screen have been installed for each well, a sand or gravel pack will be emplaced between the screen and the boring wall. The pack will consist of washed and bagged rounded sand or gravel with a grain size distribution compatible with the screen and the formation. Texas Blastsand No. 1A has been used successfully at AF Plant 4 and will probably be the

TABLE 6-1. UPPER ZONE MONITOR WELL MATERIALS FOR AF PLANT 4 INVESTIGATION

1. Casing: Two-inch diameter, threaded and flush joints, Schedule 40 PVC

2. Screen: Two-inch diameter, threaded and flush joints, Schedule 40 PVC, 0.020-inch slot. Normal screen length will be 10 feet

3. Sand/gravel pack: Washed, bagged and rounded sand/gravel with grain size compatible with screen slot and formation. A sand pack will be emplaced from bottom of the borehole to 2 feet above the top of the well screen.

4. Bentonite seal: Two feet of granulated or pelleted bentonite will be placed above the bottom sand section.

5. Grout: Neat cement (Type I Portland cement) grout will be tremied from the top of the bentonite seal to land surface. A grout mixture of 6:1 Portland cement and bentonite will be used. The grout will be allowed to set for at least 12 hours prior to any well development activities.

6. Surface completion: The PVC casing will be cut off to provide a two to three foot stickup and a solid cap will be placed on the casing. A three-inch diameter protective steel casing, four-feet in length, will be placed over the exposed PVC casing, and seated in the cement. A locking cap lid will be installed on the protective steel casing.

7. Alternate flush completion: The PVC casing will be cut off after installation about 3-inches below ground level. An end plug or casing cap will be provided for each well. An iron or steel flush utility type box will be placed over the exposed casing and seated cement. A locking well cap lid or box will be used. The utility box cover will be painted for corrosion control and visibility.

8. Guard pipes or posts: 3" diameter steel posts, six feet in length, with a minimum of 2 feet below ground, 3 each, will be installed radially 4 feet from the wellhead (not emplaced for flush surface completion).

appropriate material for the new wells. The sand pack will be emplaced from the bottom of the borehole to 2 feet above the top of the screen.

Granulated or pelletized bentonite will be placed above the sand/gravel pack to a minimum thickness of two feet to provide an adequate seal. The auger flights will be used as the tremie pipe for bentonite emplacement. The bentonite seal may be wetted in the hole using 1-2 gallons of formation water on potable water to insure that the seal is developed before cementing operations begin.

Neat cement (Type I Portland cement) grout will be emplaced from above the top of the bentonite seal to land surface. A grout mixture of 6:1 Portland cement and bentonite powder will be used. Grout will be emplaced after the auger string is withdrawn for water table conditions. If artesian conditions exist a small diameter tremie pipe will be used. The tremie pipe will be inserted between the 2 inch well casing and the inside wall of the auger flights for grout emplacement.

Each well will be completed with steel protective pipes, a cap and locking hasp, and clearly numbered with an exterior paint or metal die stamp. If the base determines the well is in an area which needs additional protection, three three-inch diameter steel guard posts will be installed radially away from the wellhead. Each guard post will be six feet in total length and will be recessed two feet into the ground. A lock will be provided to prevent unauthorized removal.

A flush well surface completion may be required in areas of extensive aircraft and vehicular traffic. In the case of flush completion, the PVC casing will be cut two to three inches below land surface, and a PVC casing cap will be provided to prevent infiltration of surface water into the casing. The protective lid will consist of a cast-iron valve box assembly cemented in place with concrete. Specific guidance on an acceptable flush box type, and any special cementing requirements will be provided by General Dynamics. Care

will be taken to maintain free drainage within the valve box. A locking system will be provided to discourage any tampering.

Paluxy Monitor Wells

Air rotary drilling will be used to advance the borehole for the Paluxy wells. A pilot borehole through the upper zone alluvial material will be made to a depth of at least 5 feet into the underlying bedrock. The borehole will then be reamed to a diameter of at least 14-inches. A 10-inch diameter steel casing will be installed to the full depth of the borehole and the annular space grouted. Upon achieving a positive seal, the borehole will then be advanced using a 6-inch diameter (or greater) bit to the final depth at the top of the shale unit dividing the upper and lower Paluxy Formation. If borehole stability is a problem, bentonite drilling fluid may be necessary while drilling in the Paluxy. As the borehole is advanced, the cuttings discharged at the surface will be examined for lithology, moisture, and other features useful in describing the geologic section. Drilling conditions, such as relative rate and ease of penetration, will be noted by the driller. Water encountered during drilling will be noted with respect to depth of occurrence and rate of production. If needed, drilling will be suspended temporarily to allow for recovery of water in the borehole.

After drilling operations are completed, the Paluxy monitor wells will be installed as follows. Screen and casing, consisting of 5-inch diameter Schedule 80 PVC, will be installed into the 10-inch borehole. Gravel pack material (e.g., Texas Blastsand No. 1A) will be placed in the annular space to a level of five feet above the top of the screen. Bentonite pellets will be added to form a 2-foot thick seal, and then annular space will be grouted to the surface by the tremie method. The well will be developed by bailing until a sediment-free discharge is produced. A dedicated stainless steel submersible pump will be installed in each well after development. Protective casing, surface electrical connections, and a concrete well pad will be placed after the pump is installed.

6.7 Well Development

After each monitor well is installed, it will be developed through Upper Zone wells by use of a bottom-filling bailer and the Paluxy wells with submersible pumps. The well will be surged until the supervising hydrogeologist determines that development is complete. Minimal development is expected as no drilling fluids are expected to be used. A new bailing rope will be used at each Upper Zone monitor well and the bailer will be decontaminated in the same manner as the split-spoon sampler. The amount of ground water purged will be measured and recorded.

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7.0 SAMPLE AND DATA ACQUISITION

7.1 Ground-Water Level Measurement

Following completion and development of the Phase II Stage 1 monitoring wells, a round of synoptic water level measurements will be taken on the new wells and all previously installed monitoring wells. Water levels will be measured to the nearest 0.01 ft. from the top of the marked casing using an electric line water level indicator. The instrument will be lowered down the well and the depth to water from the top of the blank casing will be recorded. Additional water level measurements will be taken prior to sampling.

7.2 Surveying of Wells

A professional surveyor will be retained to survey the vertical elevations of the top of casing of newly-installed monitoring wells to an accuracy of $\pm$ 0.01 foot. All surveying will use an established U.S.G.S. or U.S.C.G.S. bench mark as point of origin. Horizontal locations of monitoring wells and boreholes will be determined to an accuracy of 1.0 foot.

All surveyed points will be recorded on site maps. Existing well locations will be determined from General Dynamics drawings and maps. The locations and elevations are essential to the determination of ground-water flow directions.

7.3 Purging and On-Site Analyses

7.3.1 Well Purging

Each well will be purged immediately prior to sample collection to ensure that fresh formation water is collected. Purging operations will be conducted using either a dedicated pump or a bottom-discharge bailer if the

well is not equipped with a pump. Purging operations will be considered complete when three wetted well casing volumes have been displaced or when the pH, temperature, specific conductance, color and odor of the discharge are stabilized. Ground-water samples from the Upper Zone wells will be collected with a Teflon bailer or 2-inch stainless steel Kemmerer sampler. The latter sampler can provide non-aerated ground-water samples at discrete depths which aids in insuring the integrity of any volatile chemicals in the ground-water. Ground-water samples from the Paluxy wells will be taken from installed sampling taps.

All down-hole equipment used during the purging of the monitor wells will be carefully washed with a laboratory grade detergent and rinsed with methanol and distilled water to prevent cross-contamination. As an additional step to prevent cross-contamination of the wells, purging/sampling operations will progress from areas suspected to contain little or no contamination to areas assumed to have higher contaminant levels.

7.3.2 Field Analysis

All water samples collected shall be analyzed on-site for temperature, pH, and specific conductance. Measurements of the sample temperature will be taken using a mercury thermometer. This field measurement represents the temperature of the aquifer unit at a particular location and time. This measurement will also be used to calibrate the pH and conductivity meters in the field. The pH of each sample will be measured with a Myron L P DS pH/conductivity meter (Model EP10/pH). The specific conductivity of each sample will also be measured with a Myron L P DS meter (Model EP10/pH).

7.4 Sampling for Laboratory Analyses

Water samples collected will be placed in laboratory prepared containers, appropriately preserved, chilled to 4°C and shipped to Radian Analytical Service Laboratories in Austin, Texas and/or Sacramento, California.

Soil and sediment samples will be frozen using dry ice and shipped to the Radian laboratories.

All soil and water samples will be split with one set delivered to USAF OEHL/SA at Brooks AFB, Texas. Sample splits sent to USAF OEHL/SA will be accompanied by completed AF Form 2751 or 2752 along with copies of field logs documenting sample collection. An additional 10 percent of all samples will be split and analyzed in duplicate fractions as part of the laboratory quality control protocol. Radian chain-of-custody documents will accompany all samples. Analytical methods, preservations and holding times are provided in detail in Appendix C, the Project Quality Control Plan.

7.5 Split Sample Procedures

When split samples are required the sample is divided such that all the containers have a representative portion. Soil and formation samples are split longitudinally when possible and/or any loose material is divided as equally as possible among the containers. On the other hand, samples for volatile contaminants will be placed directly into the sample container with minimal disturbance. Water samples are split by pouring an equal amount of liquid among the containers for each collection. The containers are then labeled on-site and the samples are recorded in a logbook.

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8.0 WORK ZONES AND DECONTAMINATION PROCEDURES

To prevent the transport of contaminants beyond the site, it is essential to delineate work zones where personnel access and equipment movement are controlled. In this way, the potentially impacted area can be contained and the risk of contaminant transport minimized. Contaminants must be removed from clothing, personnel and equipment prior to relocation from a work zone. Three work zones will be used in this project: 1) Exclusion Zone; 2) Decontamination Zone; and 3) Support Zone.

The use of a three zone system provides maximum potential control of contaminant spread in a "worst case" scenario. Less stringent site control and decontamination procedures may be utilized if reliable information about types, amounts and locations of contaminants present on site indicates their appropriateness.

8.1 Zone 1: Exclusion Zone

The Exclusion Zone, the innermost of three concentric areas, is the zone where contamination is most likely to occur. All personnel entering the Exclusion Zone must wear prescribed levels of protection. An entry/exit point will be maintained at the periphery of the Exclusion Zone to regulate the flow of personnel and equipment, to verify that everyone who enters the site has a need to do so, and to ensure that the entry/exit protocol is followed.

The Exclusion Zone is the area where site activities (test well installation or soil sampling) are conducted and where contaminants may be present. Only properly trained individuals will be allowed to enter and work in this zone.

Decontamination stations are established at the Exclusion Zone boundary, with the traffic flow arranged so that contamination levels decrease

outwards toward the clean area. All exit traffic from within the Exclusion Zone must pass through the Decontamination Zone.

8.2 Zone 2: Decontamination Zone

Between the Exclusion Zone and the Support Zone is the Decontamination Zone, which provides a buffer between contaminated and clean areas. Zone 2 serves as a transition area to further reduce the potential of spread of contaminants to the clean zone. It provides additional assurance that physical transfer of contaminating substances on personnel, equipment and in the air is limited through a combination of decontamination, distance, air dilution, zone restrictions, and work functions.

8.3 Zone 3: Support Zone

The Support Zone is considered a "clean" area. Support equipment and the break area are located in this zone. Traffic is restricted to authorized personnel. Since normal work attire is appropriate in this zone, all potentially contaminated clothing and equipment are left in the Decontamination Zone until they are decontaminated. It is extremely important to locate the Support Zone in an area that is known to be free of contamination, and upwind of the site if practical.

On a relative basis the level of contamination should always decrease from the Exclusion Zone to the Support Zone, due to distance and decontamination procedures. Entering the Support Zone requires removal of any protective equipment worn in the Decontamination Zone.

8.4 Personnel Decontamination

Personnel leaving the designated contamination control perimeter must go through following general decontamination procedure:

1. Wash protective footwear in a designated wash container using a stiff brush.

2. Depending on the type of gloves and contamination, they should be washed or disposed of into a drum.

3. Remove goggles and hard hat.

4. Remove tyvek or other protective outer body wear and place them into a drum.

5. If respirator air filters are to be disposed of, place them into a drum.

6. Wash hands and face thoroughly using soap.

Decontamination is necessary every time a person leaves the site. Potable water is to be placed into at least 4 containers marked as A) soapy water using a liquid detergent, B) rinse water, C) final rinse, and D) boot wash.

The respirator and goggles are to be cleaned using warm soapy water, a clear water rinse and then dried.

All personnel will wash their hands, face, neck and forearms before consuming any food or liquids, smoking, or using the restroom. All personnel will take a full-body shower at the end of the work day.

8.5 Equipment Decontamination

The drilling rig and tools shall receive a thorough initial cleaning and be decontaminated after each borehole. As a minimum, all augers, casing

drive, drill rods, sampling tools, tremie pipe, etc. shall be cleaned using a heated pressure water wash. The drilling rig shall also be cleaned as necessary. All personnel will wear PVC rainsuits, gloves and face shields during steam cleaning activities. The wash pad will be cleaned prior to setting up on the next hole.

Soil samples will be obtained using either Shelby tubes, or split-spoon samplers. The tubes are to be cleaned or washed with detergent, water, methanol and distilled water prior to sampling to preclude cross-contamination. The sample is to be placed into the prewashed and certified clean containers specified by the analytical laboratory.

During soil sampling activities, periodic readings from air monitoring equipment and Draeger tubes shall be taken to see if contamination is present. Monitoring equipment is to be cleaned at least once a day using soap, clean water and paper towels after sampling. All excess samples and all well and boring area drill cuttings shall be removed and the general area cleaned following the completion of each well and boring. Drill cuttings suspected of being hazardous wastes (based on discoloration, odor, or organic vapor analysis) shall be properly containerized by the contractor for eventual disposal by General Dynamics personnel.

Prior to installation, the well screen and casing will be cleaned to remove surface contaminants.

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9.0 SAMPLE CONTROL AND DATA MANAGEMENT

This field investigation will require the acquisition and analysis of a large set of water and soil samples. Techniques for sample numbering, documentation, packing, labelling and shipping as well as data reduction and management are outlined in this section.

9.1 Sample Numbering Format

In order to ensure sample control, identification, and future correlation to date, unique sample numbers will be assigned to all samples collected. A master log of the identification numbers used will be maintained by the on site hydrogeologist for the AF Plant 4 investigation.

Primary Numbers

A general description number will be used that provides information on the monitor well location and sampling sequence. Monitor wells will be numbered in sequence to match the existing numbering system. Samples of soil will be numbered according to the depth of collection; for example, the sample collected nearest the surface at well 85 would be identified as "85-1".

Secondary Numbers

Once a sample has been identified for chemical analyses it will be assigned a multi-digit number drawn from a master file at the base Bioenvironmental Engineers. This number will then be used for the environmental sampling data control form AF Form 2752 (Figure 9-1) for water and AF Form 2751 (Figure 9-2) for soils. Specific details on the use of these forms are provided in Appendix C under the Field Investigation Quality Control Plan.

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ENVIRONMENTAL SAMPLING DATA | OEHL USE ONLY

(Use this space for mechanical imprint)

SAMPLING SITE IDENTIFIER APR (9-7)

BASE WHERE SAMPLE COLLECTED

SAMPLING SITE DESCRIPTION

DATE COLLECTION BEGAN (YYMMDD) | TIME COLLECTION BEGAN (24 hour clock) | COLLECTION METHOD ☐ GRAB ☐ COMPOSITE _______ HOURS

MAIL REPORTS TO (circle if changed) | ORIGINAL | COPY 1 | COPY 2

SAMPLE COLLECTED BY (Name, Grade, AFSC) | SIGNATURE | AUTOVON

REASON FOR SUBMISSION | A-ACCIDENT/INCIDENT R-ROUTINE/PERIODIC | C-COMPLAINT N-NPDES | F-FOLLOWUP/CLEANUP O-OTHER (specify)

BASE SAMPLE NUMBER | OEHL PID

ANALYSES REQUESTED (check appropriate blocks)

GROUP A		Hardness	00900	Residue, Settleable	50086	GROUP T	
Ammonia	00610	Iron	01045	Residue, Volatile	00505	Bromoform	32104
Chemical Oxygen Demand	00340	Lead	01051	Silica	00955	Bromodichloromethane	32101
Kjeldahl Nitrogen	00625	Magnesium	00927	Specific Conductance	00095	Carbon Tetrachloride	32102
Nitrate	00620	Manganese	01055	Sulfate	00945	Chloroform	32106
Nitrite	00615	Mercury	71900	Sulfite	00740	Chloromethane	34418
Oil & Grease	00560	Nickel	01067	Surfactants -MBAS	38260	Dibromochloromethane	32105
Organic Carbon	00680	Potassium	00937	Turbidity	00076	Methylene Chloride	34423
Orthophosphate	00671	Selenium	01147			Tetrachloroethylene	34475
Phosphorus, Total	00665	Silver	01077			1,1,1-Trichloroethane	34506
		Sodium	00929	GROUP H		Trichloroethylene	39180
GROUP D		Thallium	01059	BHC Isomers	39340	Trihalomethanes	32080
Cyanide, Total	00720	Zinc	01092	Chlordane	39350	PCBs	39516
Cyanide, Free	00722			DDT Isomers	39370		
				Dieldrin	39380		
GROUP E		GROUP G		Endrin	39390		
Phenols	32730	Acidity, Total	70508	Heptachlor	39410		
		Alkalinity, Total	00410	Heptachlor Epoxide	39420		
GROUP F		Alkalinity, Bicarbonate	00425	Lindane	39782		
Antimony	01097	Bromide	71870	Methoxychlor	39480		
Arsenic	01002	Carbon Dioxide	00405	Toxaphene	39400		
Barium	01007	Chloride	00940	2,4-D	39730	ON SITE ANALYSES	
Beryllium	01012	Color	00080	2,4,5-TP-Silvex	39760	Parameter	Value
Boron	01022	Fluoride	00951	2,4,5-T	39740	Flow [illegible]	mgd
Cadmium	01027	Iodide	71865			Chlorine Total 50060	mg/l
Calcium	00916	Odor	00086			Dissolved Oxygen 00300	mg/l
Chromium, Total	01034	Residue, Total	00500			pH 00400	units
Chromium VI	01032	Residue, Filterable (TDS)	70300	GROUP I		Temperature 00010	°C
Copper	01042	Residue, Nonfilterable	00530	Sulfides	00745		

COMMENTS

AF FORM JAN 81 2752

Figure 9-1. AF Form 2752 Used for Water Sample Shipping.

BULK MATERIAL SAMPLING DATA OEHL USE ONLY

WORKPLACE OR SITE IDENTIFIER

BASE

WORKPLACE

DATE COLLECTED (YYMMDD)

BLDG NO

MAIL REPORTS

ORIGINAL

COPY

COPY

SAMPLE COLLECTED BY (Name, grade, AFSC)

REASON FOR SUBMISSION

OEHL PID

SOURCE BEING SAMPLED

SAMPLE COLLECTION DATA

A

B NAME

C NAME

D NAME

E

MANUFACTURER'S NAME

DESCRIPTION OF MATERIAL

AF FORM 27

Figure 9-2. AF Form 2751 Used for Soil Sample Shipping.

9.2 Sample Identification Documents

Sample identification documentation is essential to effective management of a large sample set. Three types of identification documents will be used in this field investigation.

9.2.1 Sample Labels

All samples will be labelled for identification by the sample numbering system described in Section 9.1.

Sample labels will be attached at the time of collection in the field. Each sample will have a unique label which includes the pertinent data concerning the sample's origin. A Radian sample label is shown on Figure 9-3.

9.2.2 Chain-of-Custody Documents

All samples will be accompanied by Chain-of-Custody forms (Figure 9-4). When samples are shipped, the individual who ships them will sign, date, and note the time on the form. Additional data covers special instructions concerning the hazardous or non-hazardous nature of the sample. Upon receipt the form is annotated by the responsible individual at the designated laboratory.

9.2.3 Field Log Books

During field operations, bound field books will be maintained by the Radian supervising hydrogeologist(s) which will describe the methods, procedures, and events concerning sample and data acquisition. The log books will be maintained as formal documents representing complete and organized records of the field activities. The contents of the field books will include any field measurements that are taken, sample collection, times, dates, and

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Field Number

Sample Type

Client

Location

Preservative

Sampler

Date

Comment

Figure 9-3. Radian Sample Label.

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CHAIN OF CUSTODY RECORD

Field Sample No. ____________

Company Sampled/Address ____________

Sample Point Description ____________

Stream Characteristics:

Temperature ____________ Flow ____________ pH ____________

Visual Observations/Comments ____________

____

Collector's Name ____________ Date/Time Sampled ____________

Amount of Sample Collected ____________

Sample Description ____________

Store at: ☐ Ambient ☐ 5°C ☐ −10°C ☐ Other ____________

☐ Caution - No more sample available ☐ Return unused portion of sample ☐ Discard unused portions

Other Instructions - Special Handling - Hazards ____________

____

____

☐ Hazardous sample (see below) ☐ Non-hazardous sample

☐ Toxic ☐ Skin irritant ☐ Flammable (FP< 40°C)

☐ Pyrophoric ☐ Lachrymator ☐ Shock sensitive

☐ Acidic ☐ Biological ☐ Carcinogenic - suspect

☐ Caustic ☐ Peroxide ☐ Radioactive

☐ Other ____________

Sample Allocation/Chain of Possession:

Organization Name ____________

Received By ____________ Date Received ____________ Time ____________

Transported By ____________ Lab Sample No. ____________

Comments ____________

Inclusive Dates of Possession ____________

Organization Name ____________

Received By ____________ Date Received ____________ Time ____________

Transported By ____________ Lab Sample No. ____________

Comments ____________

Inclusive Dates of Possession ____________

Organization Name ____________

Received By ____________ Date Received ____________ Time ____________

Transported By ____________ Lab Sample No. ____________

Comments ____________

Inclusive Dates of Possession ____________

Figure 9-4. Radian Chain of Custody Form.

notable conditions under which the samples were collected, as well as complete descriptions of the samples themselves.

9.3 Sample Handling and Shipment

Samples will be put into the containers specified by the analytical laboratory, preserved as appropriate, and shipped in accordance with all pertinent regulations.

9.3.1 Sample Containers

Sample containers are either glass (clear or amber) or plastic with screw-on lids. The lids for the glass containers are Teflon lined. All containers are prewashed and certified clean (i.e., meet specifications for 600 series EPA test methods) by I-Chem Research, Inc. Glass containers are sheathed with a plastic mesh to protect them from breakage. Requirements for sample containers are specified by the Analytical Laboratory.

9.3.2 Sample Handling and Decontamination

Transferring material from the sampling device to the container is accomplished as follows:

For soil:

1. When placing the material into the desired container a catchment box or platform is used to contain any material which may spill outside of the sample container.

2. After sampling has been completed the spilled material is then placed into a cuttings drum for proper disposal.

3. All sampling tools (i.e., knives, spoons, etc.) will be cleaned using laboratory grade detergent and/or a solvent (methanol) followed by a distilled water rinse.

For water:

1. Same as above except that filtration may be required prior to filling the sample container such as for metals analyses.

2. After sampling has been completed the spilled material will be disposed of in accordance with Air Force Plant 4 (General Dynamics) directives.

3. Cleanup same as for soil.

4. Addition of appropriate preservatives as noted in Appendix C, the Quality Control Plan.

After the containment of the samples, the following takes place:

1. Clean the outer surface of the sample containers using potable water and paper towels.

2. Label the sample containers.

3. Identify and document sample collection point or points, depth increment of samples collected, and sampling devices used.

4. Complete logbook entries, sample labels and field record sheets with sample identification point, date, time, and names or initials of all personnel handling the sample in the field.

5. Place the samples into an appropriate container (ice chest) along with ice or dry ice. Clean off the outside of the container and prepare for shipping.

9.3.3 Procedures for Packing Samples

1. Samples will be classified according to Department of Transportation (DOT) regulations found in Title 49 CFR.

2. All samples will fall under the hazard class ORM-E, identification No. NA9188, Specific Requirements 173.1300, no exceptions.

3. Samples will be packaged according to DOT specifications 173.510 and 172 subpart B, C, and D, and Subparts A and B of Part 173.
   a) Primary receptacle (i.e., sample in correct sample container) is placed in a strong outer container which contains vermiculite for liquids and styrofoam for solids. The container is then sealed.
   b) The strong outer container (i.e., ice chest) will be marked as follows:
      - Proper shipping name: Hazardous substance, liquid or solid n.o.s.
      - Hazard Class: ORM-E (place label in upper left corner of ice chest and mark for solid or liquid as noted in Figure 9-5).
      - UN or NA#: NA9188.
      - Labels: No other label required for ORM-E. "This side up" or arrows placed on the opposite side of the ice chest if a liquid is to be shipped.

Figure 9-5. ORM-E Shipping Label.

4. Hazardous material shippers certification will be filled out and accompany the shipment. A Radian form or Federal Express form may be used.

5. Secure the container so that leakage does not occur.

9.3.4 Shipping of Samples

Samples will be delivered to Radian Analytical Service Laboratories in Austin, Texas and/or Sacramento, California via overnight express delivery. Soil and formation samples will be shipped with dry ice in coolers and water samples will be shipped with ice. All samples will be accompanied by Chain-of-Custody forms. The Chain-of-Custody documentation as noted in Section 9.2.2 will include the date, time, and conditions under which the sample was collected along with the preservation techniques and the shipping data. All samples received by Radian Analytical Service laboratories will be processed through the Sample and Analysis Management System (SAM). The system provides a dynamic, easy-to-use method for the tracking, scheduling, reporting, and laboratory management. Figure 9-6 illustrates the SAM sample tracking system. The chart demonstrates the extensive back-up capacity present for guaranteeing the high level of Quality Assurance necessary to maintain standards of technical accuracy.

9.4 Data Reduction and Reporting

Quality control for data reduction and reporting will be maintained through a sequence of accuracy checks of all calculations, reductions or transfers. Work sheets have been developed to ensure consistent laboratory data entry for most of the parameters determined in the laboratories. These sheets are designed to organize the data in a clear and logical manner, and to simplify the calculations. After an analysis is completed and a data sheet has been filled out, the laboratory manager checks the data for completeness and approves the data sheet. After the data have been entered into the SAM

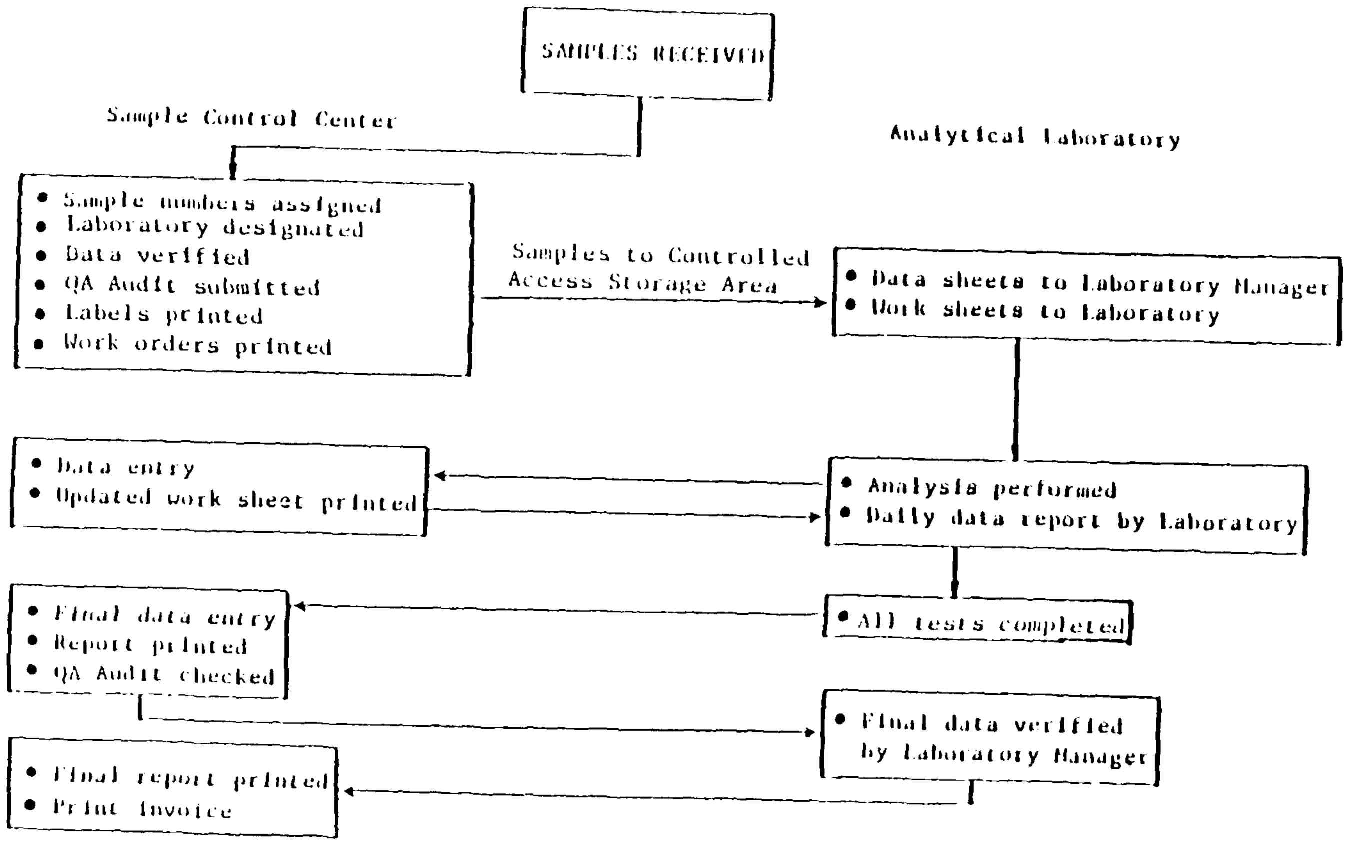

Figure 9-6. SAM Laboratory Management System.

system, an updated data sheet is printed and distributed to the contributing laboratory managers for the final data check and approval. A final report is printed, certified by the laboratory manager, and sent to the Project Director for the inclusion in the final report of the investigation. Figure 9-7 illustrates the flow of data within the SAM Laboratory Management System used by Radian.

9.5 Data Validation

All analysis results are entered into the SAM computer system. Following completion of the analyses, a preliminary report is printed and returned to the appropriate laboratory manager for review and validation. A final report is printed after the certification by the manager. This report is signed and approved by the laboratory manager before being forwarded to the client.

Following completion of the analysis and before the final data are issued, the results of the QA audit samples are compared to the certified values. The results are plotted on control charts. Separate control charts are maintained for each analysis. If results are outside the accepted control limits, the analytical results are held until the problem is resolved.

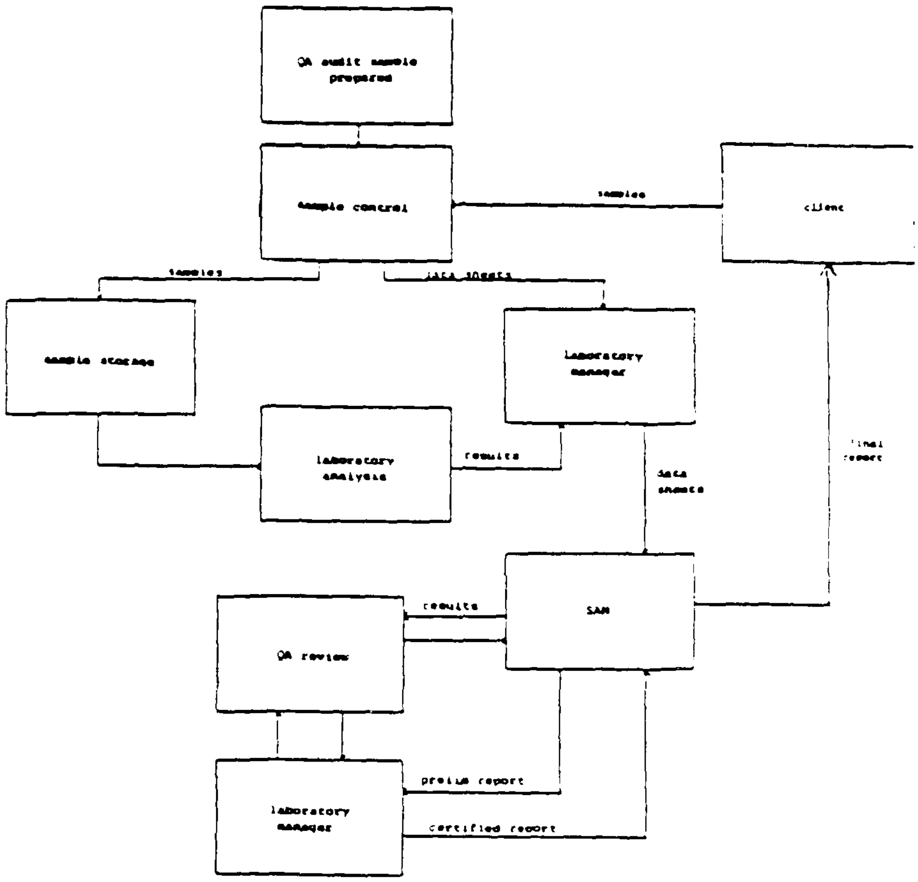

Figure 9-7. Data Flow.

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10.0 SCHEDULE

The Air Force Plant 4 IRP Phase II Stage 1 program commenced on 30 September 1985. The Technical Field Operations Plan will be completed and submitted to OEHL by 12 November 1985. The plan will also be provided to General Dynamics personnel prior to the Technical Review Committee meeting scheduled for 15 November 1985. A site visit to AF Plant 4 was conducted on 1 November 1985. At that time, Radian project personnel met with representatives of OEHL, AF Plant 4, and General Dynamics to finalize details of the field effort.

The field investigation is schedule to commence with the geophysical surveys on or about 20 November 1985. Drilling and installation of monitor wells is anticipated to begin in late January 1986. The first sample set will be collected by early February 1986. All field and analytical work is scheduled for completion by 21 March 1986.

The first of two draft reports will be submitted to OEHL for review by 20 June 1986. The report will summarize the findings of the Phase II Stage 1 investigation and present recommendations for alternative remedial actions, as appropriate. The second draft report will be submitted to OEHL within 30 days of receipt of USAF comments.

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APPENDIX A

AF Plant 4, Phase II Stage 1
Statement of Work

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85 JUL 30

INSTALLATION RESTORATION PROGRAM
PHASE II (STAGE1) - CONFIRMATION/QUANTIFICATION
AIR FORCE PLANT 4 FT WORTH TEXAS *

I. DESCRIPTION OF WORK (DOW) AMENDED

The overall objective of the Phase II investigation is to define the magnitude, extent, direction and rate of movement of identified contaminants. A series of staged field investigations may be required to meet this objective. The contractor shall determine any additional investigations required beyond this stage, including an estimate of costs.

The purpose of this task is to conduct a contaminant source investigation at Air Force Plant 4 to determine: (1) the presence or absence of contamination within the specified areas of the field survey; (2) if contamination exists, the potential for migration in the various environmental media; (3) the extent/magnitude of contamination on the Air Force Plant 4 property; and (4) potential environmental consequences and health risks of migrating contaminants based on state or federal standards for these contaminants.

Ambient air monitoring of hazardous and/or toxic material for the protection of contractor and Air Force personnel shall be accomplished when necessary, especially during drilling operations.

The Phase I IRP Report and the Hargis & Associates "Interim Progress Report Investigations of Subsurface Conditions US Air Force Plant No. 4 Fort Worth, Texas" (both mailed under separate cover) provide background and description of the sites and investigation area for this task. To accomplish this investigation the contractor shall take the following actions:

A. General

1. Well Installation:

a. Each borehole shall be drilled in accordance with ASTM procedures. Well construction shall be in accordance with appropriate state regulations. State concurrence with method of well construction shall be documented in the draft and final reports. All well installations shall be under the approval and supervised by a geologist or hydrogeologist certified by the American Institute of Professional Geologists (AIPG) or equivalent organization. Final site selection shall be coordinated with General Dynamics facility personnel to avoid interferences with existing utilities and traffic patterns.

b. Install a maximum of 22 boreholes for a total of 1160 linear feet. A maximum of sixteen (16) boreholes shall be completed as ground-water-monitoring wells for a total of 990 linear feet. The exact location, depth of boreholes and number of boreholes for each site shall be determined in the field by the contractor in consultation with the Air Force project manager. The approximate locations and number of borings and wells for sites under investigation are given in the site specific section of this task.

c. Each well shall be developed as soon as practical after completion by blowing with air and pumping or by using a bailer. Well development shall proceed

*Highlights of modification underscored.

until the discharge water is clear and free of sediment to the fullest extent practical.

d. Field permeability tests shall be performed in accordance with ASTM procedures.

e. Hollow stem auger techniques shall be used to install boreholes and monitoring wells in the upper zone (alluvium) to allow the collection of split-spoon samples. Split-spoon samples shall be collected, containerized, described and logged at 5 ft intervals or at stratum changes. Samples to be analyzed chemically (per para B.) shall be capped, frozen and package for over-night shipment to the appropriate laboratory. Two split-spoon samples from each well/borehole shall be selected based on color, odor, and organic vapor analysis (OVA) and analyzed per Table 2, Atch 2. At a minimum a soil sample from the water table interface and one additional core from each boring shall be submitted for laboratory analysis. The additional core should be from the zone judged to be the most contaminated, based on sample gas analysis, color, odor, etc.

f. Wells shall be constructed and located in a manner which will allow their use in aquifer pumping tests, ground-water recovery operations or other future uses.

g. Air rotary methods shall be used for drilling monitor wells into the Paluxy. Special precautions shall be taken to ensure that contaminants are not introduced into the Paluxy during drilling or as a result of migration around the borehole after well installation.

h. PVC flush joint casing and PVC commercially manufactured screen shall be used for all monitor wells. Use only screw type joints. Schedule 40 PVC shall be used for upper zone wells and schedule 80 PVC for Paluxy wells and any well over 100 feet deep. The screen length shall be sufficient to penetrate the aquifer of interest.

i. All wells shall be fitted with a 5 foot, protective steel casing and locking cap with lock. Three iron protective pipes shall be installed around the well for further protection in areas accessible by vehicles. Avoid wells in traffic areas when possible; when necessary install with flush mounted covers painted for corrosion control and visibility.

j. Each well shall receive a filter pack, bentonite seal and have the annular space grouted to the surface. The gravel pack shall be placed at a controlled rate to prevent bridging. A bentonite seal shall be placed above the gravel pack and a 5 foot sand layer shall then be placed above the bentonite seal. The rest of the annulas space shall be filled with bentonite/cement grout to the land surface.

k. Grouting shall be done using a tremie pipe to assure the entire filling of the annular space in one operation. No pumping or other development operation shall be permitted until the grout has cured.

l. Contaminated water from boreholes and monitoring wells shall be containerized for proper disposal or treated on-site per General Dynamics agreements. These conditions may occur during well development, purging and during pumping tests.

m. Survey elevations of all newly installed monitoring wells with respect to a U.S.G.S. Bench Mark (if available) near the Plant to an accuracy of 0.05 feet. Horizontally locate the new wells to an accuracy of 1 foot and record on site maps.

n. Well placement shall be coordinated with the proposed Remedial Action Plan as it develops.

o. Obtain any necessary State or local drilling permits.

2. The contractor shall monitor all exploratory well drilling and borehole operations with an OVA instrument to identify potential generation of hazardous and/or toxic materials. In addition, the contractor shall monitor drill cuttings for discoloration and odor. During drilling operations, if soil cuttings are suspected to be hazardous (based on OVA measurement, odors, or discoloration), the contractor shall place them in proper containers and test them for EP Toxicity, Ignitibility or organics (EPA Method 624) as appropriate. Containerized hazardous wastes shall be turned over to General Dynamics for disposal. Drums shall be labeled in accordance with the General Dynamics plant hazardous waste identification system. Results of this monitoring shall be included in boring logs.

3. Sampling and Analysis

a. All water samples collected shall be analyzed on site for pH, temperature, and the specific conductance. Sampling, maximum holding time, and preservation of samples shall strictly comply with the following references: Standard Methods for the Examination of Water and Wastewater, current edition; ASTM, Section 11, Water and Environmental Technology; Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater, EPA-600/4-82-057; and Methods for Chemical Analysis of Waters and Wastes, EPA Manual 600/4-79-020. All chemical analyses (water, sediment and soil) shall meet the required limits of detection for the applicable EPA method identified in Table 1, Attachment 1.

b. Locations where water, soil, or sediment samples are taken shall be surveyed and marked where possible with a permanenet marker, and the location documented on a project site map.

c. Split all water, sediment and soil samples as part of the contractor's specific Quality Assurance/Quality Control (QA/QC) protocols and procedures. One set of samples shall be analyzed by the contractor. The other set of samples shall be forwarded for analysis through overnight delivery to:

USAF OEHL/SA
Bldg 140
Brooks AFB TX 78235

The samples sent to the USAF OEHL/SA shall be accompanied by the following information:

(1) Purpose of sample (analyte)
(2) Installation name (base)
(3) Sample number (on containers)
(4) Source/location of sample
(5) Contract Task Numbers and Title of Project

(6) Method of collection (bailer, suction pump, air-lift pump etc.)
(7) Volumes removed before sample taken
(8) Special Conditions (use of surrogates, filtering, etc.)
(9) Preservatives used, especially any nonstandard types.

This information shall be forwarded with each sample by properly completing an AF Form 2752 (copy of form and instructions on proper completion mailed under separate cover). In addition, copies of field logs documenting sample collection parameters should accompany the samples.

Chain-of-custody records for all samples, field blanks, and quality control duplicates shall be maintained. The records shall be appended to the final report.

d. Water levels shall be measured at all monitoring wells to the nearest 0.01 feet as feet below the top of the casing elevation. Record elevations as mean sea level (MSL).

e. All wells shall be purged prior to sampling to ensure that fresh formation water is collected. Purging shall proceed until at least three well volumes of water have been displaced or until pH, temperature, and specific conductance stabilize. If water flow to the well is too low or recharge too slow to meet the above conditions, the contractor shall document the number of volumes purged and sample in the most practical manner to get a representative sample. All sampling in the upper zone shall be conducted using 2-inch stainless steel Kemmerer sampler, teflon bailer, or PVC bailer. Sampling in the Paluxy shall be done with a dedicated pump installed in each well.

f. Second-column confirmation shall be required when volatile organics (VOC) as determined by EPA Methods 601, 602, 8010, and 8020 exceed detection limits in Table 1, Atch 1. Second column confirmation shall be conducted on a maximum of 25% of the samples collected for these analyses. Total number of samples for these VOCs in Table 1, Atch 1 include these confirmation analyses. Report all procedures and conditions used. Do not report numbers unless confirmed by both columns; then only report the first column results.

g. Analyze an additional 10% of all samples, for each parameter, for quality control purposes. These shall include the columns used, conditions, and the two different retention times for major components, (replicate, intralaboratory, and/or interlaboratory analysis and blanks), as indicated in Table 1, Atch 1. Include all quality control data in draft and final report. An example summary table will be forwarded under separate cover.

h. Ground-water elevations shall be measured at three points in time on all wells. One measurement shall be taken when the well is developed, a second when the sample is obtained and the third approximately one month after sampling. Measurements shall be referenced to an established, surveyed mark-point on the top of the well casing.

i. Flow conditions shall be documented for all surface-water sampling.

j. Wells shall be sampled all at once rather than sampling individual wells as they become available.

4. All sampling equipment shall be decontaminated prior to use between samples, and between sampling locations, to avoid cross contamination. Equipment shall be thoroughly washed with a laboratory-grade detergent followed by clean water, solvent (methanol) and distilled water rinses. Sufficient time shall be allowed for the solvent to evaporate and for the equipment to dry completely. The monofilament line or steel wire used to lower bailers into the well shall be dedicated to each well or discarded after each use. The calibrated water level indicator for measuring well volume and fluid elevation must be decontaminated before use in each well.

5. The drilling rig and tools shall receive thorough initial cleaning and be decontaminated after each borehole. As a minimum, drill bits shall be steam cleaned after each borehole is installed. Drilling shall progress from the least to the most contaminated areas, if possible.

6. Field data collected for each site shall be plotted and mapped. The nature, magnitude, and potential for contaminant flow within each zone to receiving streams and groundwaters shall be estimated. Upon completion of each sampling and analysis effort, the data shall be tabulated in the next R&D Status report as specified in item VI, sequence 1 below.

7. Determine the areal extent of the sites by reviewing available aerial photos of the base, both historical and the most recent panchromatic infrared.

B. In addition to items delineated in "A." above, conduct the following specific actions at the indicated sites on AF Plant 4 :

1. General

a. Numerous sites are under active study by Hargis & Associates for General Dynamics and are summarized in "Interim Progress Report Investigation of Subsurface Conditions US Air Force Plant No. 4 Fort Worth Texas, Vol. I - VI".

b. Obtain, review and analyze the reports of ongoing studies currently being conducted by Hargis & Associates for General Dynamics. Geologic and groundwater elevation data shall be analyzed to define the hydrogeologic condition at the site. Ground-water quality data shall be analyzed to determine any statistical relationships within and among the various wells and their relation to regulatory standards as well as public health and welfare.

c. Integrate, to the maximum extent possible, any previous results the General Dynamics study performed by Hargis & Associates.

d. The feasibility of utilizing hydrogeologic models to ... levels and solute transport shall be evaluated for each site.

e. Analytical data developed previously by Hargis & As... as the above results shall be used to develop remedial action alterna... possible. At least two options shall be identified for each site description for each option shall include:

a. Engineering considerations

b. Environmental impacts and means ...

AD-A190 449 INSTALLATION RESTORATION PROGRAM PHASE 2 CONFIRMATION/QUANTIFICATION STAG..(U) RADIAN CORP AUSTIN TX DEC 87 F33615-83-D-4001 4/4

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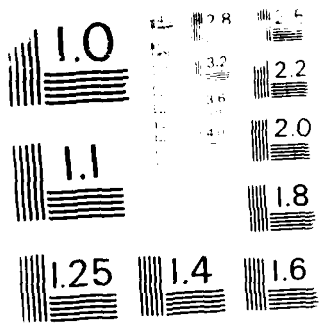
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c. Reliability and implementability

d. Operation and maintenance requirments

e. Off-site disposal needs

f. Safety considerations

2. Site 1, Landfill 1

a. Ground-water samples shall be collected at the following existing wells shown in Figure 1, Atch 3:

HM-7,10,18, 20,62,63 and P-4,7 as well as one new well being installed by General Dynamics. These samples shall be analyzed for Volatile Organic Compounds (VOC), Base Neutral & Acid Extractable Compounds (B/N), and heavy metals per Table 2, Atch 2.

b. French drains number 1 and 2 and the drain pipe shall be sampled and analyzed for VOC, B/N, and heavy metals per Table 2, Atch 2.

c. Surface water samples shall be collected at the creek seep as well as creek locations C-1,2,3,4,5 and St-5 outfall. All samples shall be analyzed for VOC,B/N, and heavy metals per Table 2, Atch 2.

d. Determine the effectiveness of the recently installed lines in the storm drain at ST-S outfall in preventing release of contaminants to the creek.

3. Site 3, Landfill 3

a. Conduct geophysical profiles (electromagnetic) to determine the horizontal extent of subsurface contamination, if present. Evaluate the data to determine if soil borings are needed to place the site onto category 1, 2, for 3.

b. Drill one (1) borehole downgradient (Figure 1) into the upper Paluxy to a depth of 150 feet. Complete the borehole as a ground-water monitor well screened in the upper sand unit.

c. Collect one ground-water sample and analyze for VOC, B/N, and heavy metals per Table 2, Atch 2.

d. Ground-water samples shall be collected at the following existing wells shown in Figure 1, Atch 3:

HM-39,38,21,37,27,26,36,35,34

as well as two new wells being installed by General Dynamics. Each sample shall be analyzed for VOC, B/N and heavy metals per Table 2, Atch 2.

4. Site 12, Chrome Waste Pit 3

a. Conduct post closure monitoring at previously installed wells to

include:

HM-30,16,15,45,17,32,13,41 and P-2

Each sample for the above wells shall be analyzed for VOC, B/N and heavy metals per Table 2, Atch 2.

5. Site 17, Former Fuel Storage Site

a. Sample the two existing wells (HM-6,14) and analyze for HC Fuels (Figure 2, Atch 4) per Table 2, Atch 2.

b. Observe well HM-6 for existence of a fuel lense and determine the thickness if such a lens exists on the water table.

c. Drill one additional borehole and complete as a ground-water monitoring well (maximum of 40 feet deep). Screen at the water table. Analyze one water sample and three (3) soil samples, for HC-fuels per Table 2, Atch2.

d. If fuel is detected in the upper zone ground water, prepare a Remedial Action Plan addressing alternatives (Item VI, Seq 4).

6. Site 2, Landfill 2

a. Conduct geophysical profiles (electromagnetic) to determine the horizontal extent of subsurface contamination, if present. Evaluate data to determine if soil borings are needed to place the site into category 1,2, or 3.

b. Install one downgradient paluxy borehole to a depth of 150 feet and complete as a ground-water-monitor well screened in the upper sand unit.

c. Obtain ground-water samples and analyze for VOC, B/N, and heavy metals per Table 2, Atch 2.

d. Ground-water samples shall be collected at the following existing wells shown in Figure 2, Atch 4:

HM-2, 22, 40, 42, 43, 44, 46

and analyzed for VOC, B/N, and heavy metals per Table 2, Atch 2.

7. Site 4, Landfill 4

a. Install one upper zone borehole to a depth of 40 feet and complete as a ground-water monitoring well. Collect and analyze one water sample and two (2) soil samples for VOC, B/N, and heavy metals per Table 2, Atch 2.

b. Install one downgradient paluxy borehole to a depth of 150 feet and complete as a ground-water-monitor well screened in the upper sand unit. Obtain ground-water samples and analyze for VOC, B/N, and heavy metals per Table 2, Atch 2.

c. Ground-water samples shall be collected at the following existing wells shown in Figure 2, Atch 4:

HM-5,9

and analyze for VOC, B/N, and heavy metals per Table 2, Atch 2.

8. Zone 1, Including: Site 13, Die Pits; Site 11, Chrome Pit 2; Site 8, Fire Department Training Area 5 (FDTA 5).

a. Ground-water samples shall be collected at the following existing wells adjacent to the excavated die pits as shown in Figure 3, Atch 5:

HM-11,12,24,25,28,60,77
P-1

b. Analyze each of the above samples for VOC, B/N, and heavy metals per Table 2, Atch 2. In addition, analyze samples for FDTA 5 (Hm-77) for HC fuels and oil & grease.

c. Drill an upper zone borehole to a depth of 40 feet and complete as a ground-water-monitor well. Collect and analyze one water sample and two soil samples for VOC, B/N, and heavy metals per Table 2, Atch 2.

9. Site 15, Fuel Saturation Area 2 (FSA 2)

a. Collect one water sample from the existing monitoring well (HM-80) and analyze for HC Fuels and VOC per Table 2, Atch 2.

b. Observe the well for existence of a fuel lens and determine the thickness if such a lens exists on the water table.

c. Drill three (3) boreholes to an average depth of 30 feet (total of 90 linear feet) along the length of the buried fuel line. Analyze three (3) soil samples from each borehole (based on color, ordor, or OVA analysis)for HC fuel & VOC pe Table 2, Atch 2.

d. If fuel saturation occurs at this site, prepare a Remedial Action Plan (item VI., Seq. 4) addressing alternatives for mitigating the problem.

10. Site 20, Wastewater Collection Basins

a. Drill one upper-zone borehole directly north and downgradient of the basins near the process building to a depth of 40 feet and complete as a ground-water-monitor well.

b. Collect one water sample and two soil samples and analyze for VOC, Oil & Grease, HC Fuels, and heavy metals per Table 2, Atch 2.

c. Collect ground-water samples at the following existing wells shown in Figure 3, Atch 5:

HM-31,47
as well as two new wells to be installed by General Dynamics. Each sample shall be analyzed for VOC, Oil & Grease, HC Fuels, and heavy metals per Table 2. Atch 2.

d. Determine the location and depth of the buried sanitary and industrial waste lines. Determine the need for sampling soil along their length based on findings in items 10.a. through 10.c.

11. Site 16, Fuel Saturation Area 3 (FSA 3)

a. Collect one water sample from the existing monitoring well (Hm-76) and analyze for HC Fuels and VOC per Table 2, Atch 2.

b. Observe the well for existence of a fuel lens and determine the thickness if such a lens exists on the water table.

c. Review results of on-going studies to determine the areal extent of saturation. Coordinate with the on-going interim Remedial Action Program.

12. Site 9, FDTA 6

a. Drill three (3) boreholes (Figure 4, Atch 6) at an average depth of 20 feet (total of 60 linear feet) and terminating at the top of the Walnut Formation. Select two soil samples from each borehole based on color, odor, or organic vapor readings and analyze for Oil & Grease, heavy metals, HC Fuels, and VOC per Table 2, Atch 2.

b. Complete one borehole as a ground-water-monitor well. Collect and analyze a sample for VOC, Oil & Grease, HC Fuels, and heavy metals per Table 2, Atch 2

c. The remaining two (2) boreholes shall be grouted to the land surface upon completion of sampling.

13. Site 6, FDTA 3

a. Check existing well (HM-33, Figure 2, Atch 4) for a fuel lenses on the water table in the borehole.

b. Convert the existing soil boring (max of 40 linear ft) to a ground-water-monitor well screened in the upper zone. Collect one ground-water sample and analyze for VOC, HC Fuels, and Oil & Grease per Table 2, Atch 2.

c. Collect one ground-water sample from existing well HM-33 and analyze for Oil & Grease, VOC, and HC Fuels per Table 2, Atch 2.

14. Site 7, FDTA 4

a. Determine the location of the old fire training area.

b. Drill one borehole to a maximum depth of 40 feet and complete as a ground-water monitoring well (Figure 4, Atch 6). Sample for a fuel lens on the water table; measure oil thickness if present.

c. Collect one ground-water sample and analyze for VOC, Oil & Grease, and HC Fuels per Table 2, Atch 2.

15. Site 18, Solvent Lines

a. Drill one downgradient upper zone borehole (Figure 3, Atch 7) to a depth of 40 feet at a location determined from existing data collected on the wells installed by General Dynamics. Collect two soil samples and analyze for Xylene, Oil & Grease, and methyl ethyl keytone (MEK) per Table 2, Atch 2.

b. Complete the borehole as a ground-water-monitoring well. Collect and analyze samples for oil & grease, xylene, and MEK per Table 2, Atch 2.

c. Collect ground-water samples from the four (4) new wells to be installed by General Dynamics. Analyze each sample for Xylene, oil & grease, and MEK per Table 2, Atch 2.

16. Site 10, Chrome Pit 1

a. Locate the disposal pit (Figure 3, Atch 5) and drill one upper zone borehole to a depth of 40 ft. Collect two soil samples and analyze for VOC and chromium per Table 2, Atch 2. Coordinate closely with General Dynamics personnel to minimize production/work delays and cost of relocating process equipment.

b. The borehole shall be completed as a ground-water-monitoring well. Collect one water sample and analyze for VOC and chromium per Table 2, Atch 2.

c. Collect one sample from existing well HM-48 as well as two new wells to be installed by General Dynamics and analyze for VOC and Chromium per Table 2, Atch 2.

17. Site 5, FDTA 2

a. Collect ground-water samples at existing monitoring wells HM-19, 49, 50, 51 (Figure 1, Atch 3) as well as three new wells to be installed by General Dynamic:

b. Analyze samples for VOC, oil & grease, and HC Fuels per Table 2, Atch 2

c. Conduct a geophysical profile (electromagnetic) of the area to determine extent of any hydrocarbon plume.

18. Site 14, Fuel Saturation Area 1 (FSA 1)

a. Install one borehole in the upper zone to a depth of 2 feet below the water table maximum depth of 40 feet (Figure 1, Atch 3).

b. Collect two soil samples and one water sample and analyze for HC Fuels per Table 2, Atch 2.

c. Collect groundwater samples from the existing wells HM-53, 55, P-6m, 6u and analyze for HC Fuels per Table 2, Atch 2.

d. Observe the monitor wells for a fuel lense and measure the thickness.

e. Coordinate with on-going interim Remedial Action Project.

19. <u>Ambient Monitoring</u>

Collect ground-water samples from the following existing wells:

HM-29, 52, 54, 56, 57, 58, 59, 61, 64
P- 5u, 5m, 10u, 10m, 9u, 9m

as well as four new wells to be installed by General Dynamics and analyze for VOC, B/N, Oil & Grease, HC Fuels, heavy metals, and chromium per Table 2, Atch 2.

20. East Parking Lot

Collect ground-water samples from the five (5) new wells to be installed by General Dynamics and analyze for VOC, B/N, Oil & Grease, HC Fuels, chromium, and heavy metals per Table 2, Atch 2.

21. FDTA North

Collect one ground-water sample from P-3 (Figure 4, Atch 6) and analyze for VOC, B/N, oil & grease, and HC Fuels per Table 2, atch 2.

22. Fuel Storage Tank

Collect one ground-water sample from HM-23 (Figure 2, Atch 4) and analyze for oil & grease and HC Fuels per Table 2, Atch 2.

23. Lake Worth Monitor Wells

a. Install a maximum of four boreholes along the northern area of the Plant that borders Lake Worth (Fig 4, Atch 6 and Fig 5, Atch 7. Each borehole shall be drilled into the Paluxy Formation. An average depth of 50 feet per borehole for a total of 200 linear feet shall be drilled.

b. Complete each borehole as a ground-water-monitoring well and collect two water samples (one month apart) at each well. Each sample shall be analyzed for VOC, B/N, and heavy metals per Table 2, Atch 2.

24. White Settlement Ground-Water Pumping Effects

a. Review data on pumping records and projected water demands for the city of White Settlement.

b. Review historical records on Paluxy wells at Plant 4, hydrogeologic and water quality data developed during ground-water investigations conducted by General Dynamics, as well as geologic data on the thickness, character, and extent of the Goodland Limestone and Walnut Formations.

c. Evaluate the impact of the above parameters on ground-water flow in the Paluxy near AF Plant 4.

d. Determine the direction of ground-water flow in the Paluxy and the zone of influence of the White Settlement wells.

25. Field Technical Operations Plan (TOP)

The contractor shall develop a detailed technical field operations plan (specified in sequence 7, item VI below) based on the technical requirements

specified in this task description. This plan shall be explicit with regards to field procedures. It shall include but is not limited to field decontamination operations, health and safety procedures, sampling protocol, well purging requirements, disposal procedures for pumped or bailed water, closure procedures for abandoned wells, QA/QC field procedures, updated field schedule, specific field permeability tests to be performed, and etc. The format is forwarded under separate cover. Applicable data listed in sequence 7, item VI below, shall be used in plan preparation.

26. Well Abandonment

a. The contractor shall abandon the boreholes not finished as ground-water-monitor wells as if contamination is present (pressure grout from bottom to top with cement grout).

b. The contractor shall evaluate available well abandonment techniques for ground water monitor wells installed at Air Force Plant 4 for this task. This evaluation shall consider that these wells will be abandoned at some future date after the study objectives have been met and there is no longer a need for monitor wells. The contractor shall recommend a candidate method(s) or technique to apply. The actual process of ground water monitor well abandonment is not a part of this study.

27. Conduct a literature search for local hydrogeologic conditions and document in the report. Much of this has been done by Hargis & Associates in General Dynamics study (sent under separate cover); Include their results.

28. Inventory all wells on Air Force Plant 4 (active and abandoned) and include in the report. The wells shall be grouped into subsets associated with a particular site, zone, or ambient area (initial grouping by OEHL will be provided under separate cover).

29. The contractor shall evaluate the total system of wells, using Kriging or other scientifically dependable approaches, and recommend an optimal well network redesign for future monitoring efforts at AF Plant 4. Wells which are not necessary for the integrity of the chemical and hydrogeological data base should be identified as candidates for abandonment.

C. Well and Borehole Cleanup

a. All well and boring area drill cuttings shall be removed and the general area cleaned following the completion of each well and boring. Although the suspected hazardous waste shall be tested by the contractor for EP toxicity and Ignitibility, the contractor is not responsible for ultimate disposal of the drill cuttings. Only those drill cuttings suspected as being a hazardous waste (based on discoloration, odor, or organic vapor analysis) shall be properly containerized by the contractor for eventual disposal by General Dynamics.

b. Insure the construction area, including storage areas utilized, are kept cl at all times. Accumulated waste and debris shall be removed on a daily basis or more frequently as directed by General Dynamics. Comply with General Dynamics Plant Service policies with respect to clean-up of the sites after drilling and sampling.

c. Assume responsibility for containment and transportation of waste

materials from drilling procedures to the waste storage site designated by General Dynamics.

D. Field Coordination

The contractor shall notify the Air Force Project Officer five (5) days in advance of field activities and sample collection dates.

E. Asphalt Repair

The contractor shall repair asphalt surfaces that are damaged due to various field activities using a quick fix concrete or cold asphalt patch to repair surfaces.

F. Data Review

1. Results of sampling and analysis shall be tabulated and incorporated in in the Informal Technical Information Report (as specified in sequence 3, item VI below) and forwarded to the USAF OEHL for review.

2. Field work accomplishments, planned work and results shall be tabulated and forwarded, as available, in the next R&D Status Report.

G. Reporting

1. A draft report delineating all findings of this field investigation shall be prepared and forwarded to the USAF OEHL (as specified in item VI, sequence 4 below) for Air Force review and comment. This report shall include a discussion of the regional/site specific hydrogeology, well and boring logs, data from water level surveys, groundwater surface and gradient maps, water quality and soil analysis results, available geohydrologic cross sections, and laboratory quality assurance information. The report shall follow the USAF OEHL supplied format (mailed under separate cover).

2. The recommendation section shall address each site and list them by catagories. Catagory I shall include sites where no further action (including remedial action) is required. Data for these sites is considered sufficient to rule out unacceptable health or environmental risks. Category II sites are those requiring additional monitoring or work to quantify or further assess the extent of current or future contamination. Category III sites are sites that will require remedial actions (ready for IRP Phase IV actions). In each case, the contractor will summarize or present the results of field data, environmental or regulatory criteria, or other pertinent information supporting these conclusions.

3. Prepare briefing materials (no more than 30 Vu-graphs) describing investigation procedures and results, as specified in item VI, sequence 9 below.

H. Meetings

The contractor's project leader shall attend five (5) meetings with Air Force and regulatory agency personnel to take place at a time to be specified by the USAF OEHL. The meeting shall take place at AF Plant 4 for a duration of one day (eight hours).

II. SITE LOCATION AND DATES:

Air Force Plant 4
Date to be established

III. BASE SUPPORT:

General Dynamics will be responsible for activities listed below :

1. Take custody of hazardous drill cuttings and contaminated well water and make proper disposal of the material.

2. Restage drums in Hazardous waste areas to provide working space for sampling and drilling activities when necessary.

3. Set up barricades to isolate drilling area from parking areas and readings.

4. Provide secure staging area for equipment.

IV. GOVERNMENT FURNISHED PROPERTY: None

V. GOVERNMENT POINTS OF CONTACT:

1. Maj George R. New
USAF OEHL/TSS
Brooks AFB TX 78235
(512) 536-2158
AV 240-2158

2. Col Marlan J. Humerickhouse
HQ AFSC/SGPB
Andrews AFB, DC 20334
(301) 981-5235
AV 858-5235

2. Maj Al Lussier
AFPRO/PD
Ft Worth, Texas
(817)763-4473
AV 838-5473

VI. In addition to sequence numbers 1, 5, and 10 in Attachment 1 to the contract, which are applicable to all orders, the sequence numbers listed below are applicable to this order. Also shown are data applicable to this order.

Sequence No.	Block 10	Block 11	Block 12	Block 13	Block 14
7 (Atch 1) Para I.B.25.	O/Time	85Oct01	85Oct11		10
3 (Atch 1) Para I.F.1.	O/Time	*	**		3
4 (Atch 1) Para I.B.5	ONE/R	*	***		8
4 (Atch 1) Para I.G.1.	One/R	86Mar21	86Apr18	86Jul11	*****
4 (Atch 1) Para I.B.9.d.	ONE/R	*	***	****	8
9 (Atch 1) Para I.G.3.	One/R	86Apr04	86Jun06	86Jul01	3

* As required by the requested analytical method.

** Upon completion of analytical effort before submission of 1st draft report.

*** Three weeks after completion of the analytical effort.

**** Two weeks after acceptance of the draft RAP.

***** Two draft reports will be required. Ten (10) copies of the first draft shall be forwarded to OEHL/TS. After incorporating Air Force comments concerning the first draft report, the contractor shall supply the USAF OEHL with one (1) copy of the second draft report. Upon acceptance of the second draft, the USAF OEHL will furnish a distribution list for the remaining 24 copies of the second draft. When the second draft is approved the contractor shall supply 50 copies plus the original camera ready copy of the final report.

TABLE 1

ANALYTICAL METHODS, DETECTION LIMITS AND NUMBER OF SAMPLES

PARAMETER	METHOD	DETECTION LIMIT	TOTAL NUMBER SAMPLES	b	TOTAL SAMPLE
Chromium	EPA 218.1	50 ug/L 5 ug/g	28G 2S	3	33
Purgeable Organics	EPA 601/602 or 8010/8020	a	106G 23S 10W	49	188
Base Neutrals and Acid Extractibles	EPA 625	c	84G 4S 10W	10	108
Heavy Metals	FR, Vol 44 3 Dec 1979	d	85G 12S 10W	12	12[illegible]
SUSPECTED HAZARDOUS WASTES :					
EP Toxicity	EPA 1310	c	20G 20S	4	44
Ignitibility	40 CFR 261.21	e	20S	2	22
Purgeables	EPA 624	c	30G 20S	5	55
HC Fuels	EPA 418.1		53G 22S 0W	8	83
Oil & Grease (IR)	EPA 413.2	100ug/L	48G 10S 0W	6	64
pH	EPA 150.1	±0.1 unit			
MEK	EPA 8015		5G 2S	1	8
Specific Conductance	EPA 120.1	1 umho/cm			
Xylene (AVO)	EPA 8020	c	5G 2S	1	8

NOTES (TABLE 1) :

a. Detection limits for Purgeable Organic Compounds shall be as specified for the compounds by EPA methods 601-602 and 8010-8020 (soils). These methods for purgeable organic compounds requires positive confirmation by a second gas chromatographic column. This must be done before reporting positive values. Second column confirmation is required when values exceed:

Benzene	0.7 ug/L
Carbon Tetrachloride	4.0 ug/L
1,2 Dichloroethane	0.1 ug/L
Methylene Chloride	4.0 ug/L
Tetrachloroethylene	4.0 ug/L
Trichloroethylene	1.0 ug/L
Vinyl Cnloride	1.0 ug/L
Dichlorobenzene isomers	Sum greater than 10 ug/L
Any other organic	Greater than 10 ug/L

Retention time on both columns must match before reporting positive value. If no match, it will be considered as interference.

If questions are encountered about certain contaminants, you may be asked to show both chromatograms used to rule out possible interference.

b. Includes 10% QA/QC for all samples and 25% second column analyses on EPA Methods 601, 602, 8010, and 8020.

c. Detection limits specified by the EPA or Standard method.

d. Heavy Metals :

METAL	ug/L of Leaching Solution
AS	10
Ba	200
Cd	10
Cr	50
Pb	20
Hg	1
Se	10
Ag	10

e. Find if sample is ignitible at 140 degrees Farenheit or below. If so, it is a hazardous waste.

TABLE 2 Summary of Site Specific Analyses at AF Plant 4; Phase II Stage 1

SITE	LOCATION	#BH	BH(FT)	#MW	MW(FT)	TYPE SAMPLE	VOC	B/N	O&G	Heavy Metals	Fuel HC	XYLENE	Cr	MEK
1	Landfill 1					G	9	9		9				
						W	10	10		10				
3	Landfill 3	1	150	1	150	G	12	12		12				
12	Chrome Waste Pit 3					G	9	9		9				
17	Former Fuel Storage Site	1	40	1	40	G					3			
						S					3			
2	Landfill 2	1	150	1	150	G	8	8		8				
4	Landfill 4	2	190	2	190	G	4	4		4				
						S	2	2		2				
	Zone 1	1	40	1	40	G	9	9	1	9	1			
						S	2	2		2				
15	Fuel Saturation Area 2	3	90			G	1				1			
						S	9				9			
20	Wastewater Collection Basins	1	40	1	40	G	5		5	5	5			
						S	2		2	2	2			
16	Fuel Saturation Area 3					G	1				1			
9	FDTA 6	3	60	1	20	G	1		1	1	1			
						S	6		6	6	6			
6	FDTA 3	1	40	1	40	G	2		2		2			
7	FDTA 4	1	40	1	40	G	1		1		1			
18	Solvent Lines	1	40	1	40	G			5			5		5
						S			2			2		2
10	Chrome Pit 1	1	40	1	40	G	4						4	
						S	2						2	
5	FDTA 2					G	7		7		7			
14	Fuel Saturation Area 1	1	40			G					5			
						S					2			
	Ambient Monitoring					G	19	19	19	19	19		19	
	East Parking Lot					G	5	5	5	5	5		5	
	FDTA North					G	1	1	1		1			
	Fuel Storage Tank					G			1		1			
	Lake Worth Monitor Wells	4	200	4	200	G	8	8		8				
	Sub Totals	22	1160	16	990		139	98	58	111	75	7	30	7
	QA/QC Samples						49	10	6	12	8	1	3	1
	Total Samples with QA/QC						188	108	64	123	83	8	33	8
SITE	LOCATION	#BH	BH(FT)	#MW	MW(FT)	TYPE SAMPLE	VOC	B/N	O&G	Heavy Metals	Fuel HC	XYLENE	Cr	MEK

Key (Table 2):

VOC = Volatile Organic Compounds
B/N = Base Neutral and Acid Extractables Compounds
O&G = Oil and Grease
Samples: G = Ground Water W = Surface Water S = Soil

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212-027-27

7 January 1986

Major George R. New
USAF OEHL/TS
Brooks AFB, TX 78235

REF:F33615-83-D-4001/0027 AF Plant 4

Dear Major New:

Based on our review of comments on the draft Technical Operations Plan and our telephone conversation on 2 January 1986, Radian understands that the following changes will be made in the technical approach and schedule for the IRP Phase II work at AF Plant 4.

Requested Changes to Statement of Work:

I.A.1.j - Well Installation:

We request that the reference to the 5 foot sand layer to be place above the bentonite seal be deleted. Our belief is that the integrity of the well would be improved by a continuous grout column above the bentonite seal.

I.B.12 - Site 9, FDTA 6

Results of previous investigations and observations made during the removal of contaminated soils have shown that alluvial material is very thin in the area. Therefore, the requirement for two soil borings and one ground-water monitor well will be changed to the collection and analysis of six soil samples by hand augering. These samples will be analyzed for oil & grease, volatile organic compounds, hydrocarbon fuels, and heavy metals.

I.B.14 - Site 7, FDTA 4

Since the location of the site is not well defined, a soil gas survey will be conducted in the area in order to better define the location on the basis of soil gas measurements. It is recognized that the general area is currently receiving fill and debris from construction at another area of the plant. The survey will be conducted in the suspected area of the fire training area subject to limitations with field access. Following an analysis of the survey results, one ground-water monitor well will be installed, if appropriate.

8501 Mo Pac Blvd P O Box 9948 Austin Texas 78766 512/454 4797

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Major George R. New
7 January 1986
Page Two.

I.B.23 - Lake Worth Monitor Wells

One ground-water monitor well will be installed in the upper member of the Paluxy Formation, as opposed to four wells specified in the current delivery order. The initial recommendations made by EPA for the installation of wells along Lake Worth's shoreline were offered before the installation of at least sixteen upper zone wells downgradient of the disposal areas west and north of the plant. We believe that the hydrogeologic features of much of the area of concern has been adequately characterized, allowing for the reduction in the number of monitor wells for this effort. The proposed monitor well will be located northwest of the plant in order to complement the location of existing well P-3.

Requested Adjustment in Delivery Order Schedule:

The combination of the additional soil gas investigation, review time needed for the Technical Operations Plan, and additional coordination with the other ongoing field investigations at AF Plant 4 will require more time than originally anticipated in mid-1985. Accordingly, we request that the schedule be adjusted so that Block 11 (completion of field activities) will be 86Apr25, Block 12 (due date for the draft report) will be 86Jun20, and Block 13 (due date for the draft final report) will be 86Sep12.

At the present time, it appears that these items can be accomplished within the overall budget for the program. We propose to allocate funds that would have been expended on the construction of the deleted monitor wells and analysis of some water and soil samples from these wells for the performance of the soil gas survey. We are currently gathering cost and schedule data concerning the soil gas survey and will keep you informed of any changes that may be appropriate.

Thank you for your consideration of these requests. Please let me know if you have any questions about these items.

Sincerely,

Lawrence N. French

Lawrence N. French
Project Director

cc: W. M. Little
M. F. Conover

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APPENDIX B

Health and Safety Plan

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212-027-29 Delivery Order No. 29

APPENDIX B

INSTALLATION RESTORATION PROGRAM

PHASE II-CONFIRMATION/QUANTIFICATION

STAGE 1

HEALTH AND SAFETY PLAN

FOR

AF PLANT 4, TEXAS

Prepared by:

Radian Corporation

Under Contract

F33615-83-D-4001

Submitted to:

UNITED STATES AIR FORCE
Occupational and Environmental Health Laboratory
Brooks AFB, Texas 78235

11 November 1985

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1.0 INTRODUCTION

This document describes the safety and health procedures that will be in force for the Phase II Stage 1 investigation at Air Force Plant 4, Texas. All Radian employees and subcontractors will follow this plan. Any variances must be cleared through the Project Director prior to implementation.

The primary responsibility for employee safety rests with 1) Radian for its employees; and 2) Subcontracting supervisory personnel for their employees. Radian, its Subcontractors, and other parties participating in field activities will comply with all applicable requirements of the Occupational Safety and Health Administration.

2.0 FIELD ACTIVITIES/SAFETY RESPONSIBILITIES

The purpose of this Phase II (Stage 1) task is to undertake a field investigation at AF Plant 4 to determine:

- extent of environmental contamination
- the direction and flow of contaminant plumes
- the extent of environmental damage and/or health risks
- sites which warrant remedial action

2.1 Field Activities at Phase II Stage 1 Sites

Field activities to be performed during this investigation include geophysical surveys, drilling, installation of monitor wells, and sampling and analysis of ground water, surface water, and soil. Detailed descriptions of these activities are provided in Sections 2.0 and 6.0 of the Technical Operations Plan.

2.2 Safety Responsibilities of Key Personnel

The following sections provide information on the responsibilities of the IRP Team Members at AF Plant 4.

2.2.1 Safety Responsibilities of the Radian Project Officer

The Radian Project Officer will be the Project Director, Supervising Geologist, or Sampling Team Leader, depending on the type of activity. The Project Officer will be the Project Director, Supervising Geologist or Sampling Team Leader, depending upon the type of activity. The Project Director will be responsible for executing the safety procedures that are described in this plan. These safety procedures cover all on-site activities of Radian and direct subcontractor personnel. The responsibilities of the Project Officer are listed below:

- Locate the support facilities in an uncontaminated area,
- Initiate contact with the local emergency response agencies (police, fire, medical) and test the emergency phone numbers to ensure their accuracy,
- Implement the safety training as described in Section 8.0 of this plan,
- Observe site activities to ensure the proper use of personal protective equipment,
- Conduct daily safety review sessions for the drilling crew,
- Ensure that work schedules, dependent on work levels and outside temperature are set each day and adhered to throughout the work day,

- Ensure that the field team observes the work zone and decontamination procedures as described in this plan,

- Ensure that safety equipment is maintained properly (respirators are cleaned after each day), and

- Initiate corrective action for observed safety violations and report unsuccessful attempts to correct a violation to the Program Manager.

2.2.2 Safety Responsibilities of the Drilling Contractor Supervisor

The Contractor Supervisor (Drilling Supervisor) will be responsible for the performance of the duties presented below:

- Enforcement of the safety procedures that are presented in this plan.

- Initiation of corrective action and, as appropriate, disciplinary and/or dismissal measures.

3.0 HEALTH HAZARD INFORMATION/JOB SAFETY ASSESSMENT

A review of previous analytical investigations into the type of contaminants present in the ground water beneath Air Force Plant 4 indicates the presence of the chemicals listed below. These contaminants exist, in most cases, in concentrations well exceeding current drinking water guidelines.

Acenaphthene	Fluorene
Arsenic	Hydrocarbon fuels
Benzene	Isophorone
Cadmium	Lead
Chlorobenzene	Methylene chloride

Chloroform	Naphthalene
Chromium	n-Nitrosodiphenylamine
1,2-Dichlorobenzene	Phenanthrene
1,3-Dichlorobenzene	Pyrene
1,4-Dichlorobenzene	1,1,2,2-Tetrachloroethylene
1,1-Dichloroethane	Toluene
1,2-Dichloroethane	1,1,1-Trichloroethane
1,1-Dichloroethylene	1,1,2-Trichloroethane
1,2-Dichloroethylene	Trichloroethylene
1,2-Dichloropropane	Trichlorofluoromethane
Ethylbenzene	Vinyl chloride

3.1 Chemical Hazards

Chemical hazards to the field team exist when liquid or solid samples from the site contact human tissue. Every effort will be made to avoid contact with contaminated materials.

Routes of Exposure

The investigation team may be exposed to the contaminated soils and ground water through inhalation, ingestion, and skin and eye contact.

- Skin contact with solid or liquid samples that are contaminated occurs when a worker does not wear proper protective clothing around sampling activities.

- Eye contact with liquid or solid samples that are contaminated occurs when a worker does not wear splash goggles around places where samples are being taken or handled.

- Respiratory system contact with samples that are contaminated occurs due to lack of or improper use of respiratory protection equipment.

- Gastro-intestinal system contact with samples can occur when workers do not pay attention to personal hygiene rules designed to reduce the chance of ingesting site contaminants, (hand washing before smoking, eating, or drinking anything on site).

3.2 Physical Hazards

The field team can be exposed to a number of physical hazards during this project. Physical hazards that may be encountered are:

- Noise
- Drilling hazards
- Climbing hazards
- Heat Stress
- Frostbite
- Lacerations and Contusions
- Snake, Insect and Animal Injuries
- Lifting hazards

Noise Exposure

The field team will be exposed to excessive noise levels from drilling equipment and from aircraft engines in the taxi and maintenance areas about the facility. Therefore, hearing protection may be necessary while installing test wells or soil borings at the site.

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Drilling Hazards

Drilling represents one of the most dangerous operations in the work plan. Hazards include:

- o Possible excavation of buried electrical cables or gas mains
- o Contact with overhead power lines while raising the derrick or mast
- o Injury from being entangled or crushed by the moving tools
- o Chemical exposure from drilling through contaminated materials or unsuspected buried wastes

Drilling must be stopped and the derrick lowered during thunderstorms or high winds. In the event of a vapor release while drilling, operations must be stopped, the hole secured, and the site evacuated until the situation can be resolved.

Climbing Hazards

In the course of the drilling activity, workers may have to work on equipment by climbing the mast. When such work must be performed, the individual will be required to wear a safety harness and will be overseen by the drilling subcontractor supervisor and Radian Project Officer.

Heat Stress Hazards

During this project, workers may be required to wear protective clothing which insulates the body. A hazard may exist if workers wear protective clothing in temperatures over 65°F.

Frostbite Hazards

Prolonged exposure to excessive cold and wet conditions may cause excessive loss of body heat (hypothermia) and/or frostbite. Since drilling activities at AF Plant 4 will occur during the winter months, the Project Officer must be alert to the signs and symptoms of frostbite and hypothermia.

Lacerations and Contusions (Cuts and Bruises)

The field team may suffer cuts or bruises during this project due to the fact that drilling activity usually involves contact with moving machinery and physical objects. The Radian Project Officer should be prepared to deal with cuts and bruises.

Snake, Insect and Animal Injuries

The field team should be aware that site activities, primarily in remote areas, may disturb the local wildlife. Activities conducted near housing areas may also aggravate domestic animals. Snakes, animals, and some insects can and will bite. Prompt first aid measures are extremely important. All field team members should be properly briefed regarding the potential for encountering wildlife as well first aid measures in the event of animal-caused injuries.

Lifting Hazards

Field team members may be exposed to injury caused by lifting heavy objects due to the fact that drilling operations involve manual movement of heavy drilling casing, auger flights, and various other pieces of equipment. All field team members should be trained in the proper method used to lift heavy equipment and cautioned against lifting objects that are too heavy for one person.

3.3 Fire and Explosion Hazards

Fire or explosion may result from excavating or drilling into buried gas lines or unsuspected chemical wastes or from contacting undetected ordnance and ammunition.

4.0 PERSONAL PROTECTIVE EQUIPMENT

During drilling and sampling, Radian employees will be provided with and required to wear personal protective equipment designed to prevent skin and respiratory contact with possible site contaminants. The drilling supervisor will be responsible for personal protective equipment and personnel training.

4.1 Dermal Protection

The drilling operations may expose Radian employees to certain dermal hazards, should contaminated soil or ground water come in contact with their skin, hands, or eyes.

When the chance for skin, hand, or eye contact is present, wear the following protective clothing:

- o Heavy duty butyl rubber gloves will be worn by all field team members when they are handling the soils or ground-water samples from the drilling operations.

- o Disposable latex gloves worn under two pair of disposable PVC gloves may be worn by personnel engaged in sample splitting or other activities that require a high level of manual dexterity.

- o Disposable Tyvek coveralls will be worn by the field team when the drill cuttings are wet, when the field team must handle any

of the drilling equipment (auger flights, etc.) that have contacted the contaminated material, and during steam cleaning operations.

- Viton gloves and Saran-coated Tyvek coveralls with hoods must be worn during all field activities at Landfill 1 and Landfill 3 and during decontamination of equipment used in these areas.

- Eye protection (Safety Glasses with side shields) will be worn by all field team members during all drilling activity. Splash goggles will be worn during steam cleaning activity.

- Neoprene or PVC boots with steel toes and shanks will be worn by all field team members during activity that requires them to stand in or walk through contaminated soils or standing water.

- Protective clothing (coveralls, boots, gloves) must be changed or decontaminated immediately if it becomes grossly contaminated or if it is wet.

4.2 Respiratory Protection

The following guidelines will be in force regarding respiratory protection:

- Air-purifying respirators fitted with organic vapor cartridges and dust pre-filters will be worn when drilling occurs in known or suspected waste material at all sites except Landfills 1 and 3. If at any time air monitoring indicates that this level of respiratory protection is inadequate, activities will cease immediately and the site will be evacuated.

- The type of air-purifying respirator approved for this work will be the MSA Comfo II mask or equivalent as coordinated with the Radian Health and Safety Officer. Mine Safety Appliances (MSA) Type GMA-H combination filter/cartridges will be used on this project. These cartridges are selected for protection against organic vapors and dusts, mists, fumes, and radionuclides. They are effective against 0.3 micron dust particles.

- Additional respiratory protection will be required for activities at Landfill 1 and Landfill 3. The types and concentrations of chemical contaminants identified to date indicate that positive-pressure supplied air respirators will provide the best protection. This level of protection must be worn during field activities at both these sites.

- The type of supplied air respirator approved for this work will will be the MSA Self-Contained Breathing Apparatus (SCBA). Only Grade D or better quality air will be used in this equipment.

4.3 Hearing Protection

Since operations will be conducted near aircraft engines and jet taxi and maintenance areas, the noise level of these activities combined with the drilling rigs will be excessive. The field team must protect their hearing during drilling operations by wearing either or both of the devices listed below:

- Disposable roll-up ear plugs,
- Ear muffs.

4.4 Head Protection

Head protection will be worn by all employees at all times while they are on site. The type of head protection selected for this type of job is a non-conductive, impact-resistant hard hat (Class A helmet).

5.0 PERSONNEL TRAINING

During drilling and sampling of the sites, Radian employees will be provided with and required to wear EPA Level B and C protective devices. EPA Level C protection is used where minimal respiratory and skin hazards are present. It consists of full-face or half-face chemical cartridge or canister respirators with appropriate chemical-resistant clothing such as Tyvek coveralls. Radian uses EPA Level C protection combined with an assessment of the respiratory and skin hazards to develop an effective personal protective plan. Since there is a chance for chemical contact with skin, eyes or hands, EPA Level C protection is required as a minimum. Site activities at Landfills 1 and 3 will require the additional protection afforded by EPA Level B. This consists of waterproof, chemically-impervious clothing with hood; full-face positive-pressure supplied-air respirators; and impervious boots and gloves with taped joints. The following sections discuss personal protection training required for the work at AF Plant 4.

5.1 Respiratory Training

Respirators will be provided to the field team by their respective firms. The team members will be expected to use these respirators properly. This section provides information on the following topics:

- o Why respiratory protection is required
- o The nature, extent, and effects of the respiratory hazard to which the worker may be exposed

- o The capabilities and limitations of air-purifying and supplied-air respirators

- o Requirements for upgrade from air-purifying to supplied-air respiratory protection

- o How to inspect, don, wear, and clean the respirator

- o How to test the fit of the respirator

5.1.1 Capabilities of the Air Purifying Respirator

The half face air purifying respirator is capable of filtering dusts, mists, fumes and particulates out of inhaled air. This mask does not provide oxygen and should not be used in oxygen deficient atmospheres. The mask will not provide adequate protection if the face seal is poor, and all members of the field team will be required to be clean shaven before wearing this mask. It is a violation of OSHA regulations to wear this mask with any facial hair that interferes with the face seal.

5.1.2 Instructions for Inspecting and Fit Testing

Respirators require frequent inspection to detect missing, worn, and deteriorated parts. Defective or missing parts must be replaced to ensure proper operation of the respirator.

The half face mask is relatively simple in appearance, yet it has many parts. Each of the component parts are subject to wear or deterioration. Some parts require frequent replacement.

The Radian Project Officer will point out the following parts of the mask to the field team at the start of the field activities:

- Facepiece
- Strap support frame
- Inhalation valve
- Inhalation valve seat
- Cartridge gaskets (2)
- Filter cartridges (2)
- Exhalation valve
- Exhalation valve seat
- Exhalation valve cover

When inspecting the respirator, consider the following items:

- The respiratory body may become contaminated with various materials as it is worn during a work shift. Care must be taken to prevent these materials from getting inside the respirator where it may be inhaled or swallowed. If the respirator is removed from the face during work, it should be laid down on a clean surface or stored temporarily in a plastic bag.

- Allowing the respirator to hang from the neck can result in contamination of the facepiece.

- Should contamination of the respirator body occur during work, a clean damp cloth can be used to clean dirt and contamination away. If the respirator becomes contaminated with chemicals it should be turned in to the Radian Project Officer or drilling supervisor and a clean respirator should be obtained.

- The respirator body is made of synthetic rubber which will eventually deteriorate. The body may crack, develop tears; therefore, it should be inspected before each use.

- Headstraps should be inspected for:
  - breaks or tears
  - loss of elasticity
  - broken buckles

- Before each use the inhalation and exhalation valves should be checked for:
  - detergent residue, dust, or dirt on the valve or valve seat
  - cracks, tears, distortion in the valve material
  - missing or defective valve cover

- The two inhalation valves and valve seats are located inside the respirator body.

- The exhalation valve is located on the underside of the mask and is covered by a valve cover.

- Respirator filters should be checked to determine:
  - the proper filter is present
  - the filter carries a NIOSH approval
  - the filter gaskets are in place
  - the filter threads and cartridge holders are intact and not deteriorated

- The Project Officer will show the field team how the filters fit in the filter holders.

- Respirators should be cleaned and disinfected after each use. Each employee will be required to clean his or her own mask.

- The body of the mask should be washed in a mild detergent and thoroughly rinsed with clean water.

- After washing the respirator (cartridges removed), the mask should be allowed to dry in a safe, clean, dry environment.

To don the mask, place your chin inside the chin cup at the lower portion of the mask. Next, fasten the lower neck strap around the back of your neck and place the top strap on the back crown of your head.

Respirators must fit properly to afford adequate protection. To ensure that a proper fit is obtained, fit testing is performed. The Project Officer will perform three types of fit tests at the start of field activities and will insure that each person is periodically checked throughout the project. These tests are:

- Negative pressure testing
- Positive pressure testing and
- Odor testing.

5.1.3 Capabilities of the Supplied-Air Respirator

Supplied-air respirators (SCBA's) are used if the nature of the respiratory hazard is unknown or if the concentration of toxic pollutants is too high to allow the use of air-purifying respirators. The SCBA provides its own air supply and is suitable for use in Immediately Dangerous to Life and Health (IDLH) atmospheres. The full-face mask provides additional protection for the eyes from high vapor concentrations. The SCBA must be worn in any environment that contains concentrations of vapors that exceed the purifying capacity of the cartridge respirator. Generally this is determined to be at total vapor concentrations of 1000 ppm or of any single constituent at more than 10 times its Threshold Limit Value (TLV).

5.1.4 Inspection and Use of Supplied-Air Respirator

Prior to beginning inspection of the SCBA, check to see that the high-pressure hose is securely seated on the cylinder fitting, that the Bypass and Mainline valves are closed, and that the regulator outlet cover has been removed. There should be at least 1800 psi in the tank.

Inspect the straps and buckles visually for completeness, damage, and secure locking function. Examine the cylinder backplate for cracks, missing rivets, and loose screws. The cylinder hold-down strap should fully engage and hold tightly. There should be a current hydrostatic test date marked on the cylinder. There should be no large dents or gouges in the cylinder.

The cylinder gauge should be clearly visible, with intact face, needle and protective glass. There should be no air leaking around the cylinder valve packing when it is open. Examine the high-pressure hoses for leakage, cracks and damage. Check the operation of the regulator and low-pressure alarm.

There should be no cracks or deterioration in the facepiece. The rubber straps are extremely subject to wear and should be replaced frequently. Examine the breathing tube for dirt and damage. The facepiece should be donned and subjected to a negative pressure test.

5.2 Personal Hygiene Practices

The field team must pay strict attention to the hygiene requirements listed below to avoid ingesting any of the possible site contaminants:

- Never put anything in your mouth, including your fingers.

- All employees must wash their hands, forearms, face and neck before eating, drinking, smoking, or using the restroom. There will be no exceptions to this rule.

- At the end of the day, each employee will shower thoroughly.

6.0 EXPOSURE MONITORING PLAN

Employee exposure to site contaminants and physical hazards will be monitored during the site activities by using a combination of techniques:

- Organic vapor measurements using an Organic Vapor Analyzer (OVA) or Photoionization Detector such as an HNu.

- Air quality measurements using indicating tubes (Draeger Tubes).

- Heat and cold stress monitoring conducted by the Site Safety Officer or his representative using field observations and body temperature measurements.

6.1 Chemical Exposure Monitoring Plan

The Radian Project Officer will be responsible for making measurements of the air quality during drilling activities. The OVA or HNu instrument will be calibrated prior to field use and measurements will be taken continuously during drilling and sampling activities. Draeger tube measurements using a polytest tube and chemical-specific indicating tubes will be taken at least every half hour during drilling to supplement the OVA or HNu readings. The primary reason for exposure monitoring is detection of contaminant vapors from the borehole and/or soil samples and to ensure the adequacy of personal protective measures. As required, passive dosimetry may be used as a backup measure to support the air monitoring program.

The OVA and HNu are used in the field to detect a variety of compounds in air. The two instruments differ in their modes of operations and in the number and types of chemicals they detect. Both instruments can be used to determine the presence of volatile compounds in soil and water, to make ambient air surveys, and to collect continuous real-time air monitoring data.

Prior to initial field use, all air monitoring equipment will be calibrated by a qualified equipment technician. From three to five calibration gases of different concentrations are used to check instrument response, linearity and to ensure proper operation before the instrument is taken to the field. In daily use, these instruments will be used as qualitative indicators of ambient air quality to assess health risks and exposure levels. Therefore a daily calibration check using a zero and a mid-range calibration gas should be sufficient for this purpose.

Draeger colorimetric tubes are used to measure the real-time concentration of specific organic and inorganic vapors and gases. A known volume of air is drawn through the detector tube with the pump, causing a discoloration which is proportional to the amount of contaminant present. The pump volume is factory calibrated. The detector tubes to be used at AF Plant 4 include benzene, hydrocarbon, methylene chloride, toluene, trichloroethylene and vinyl chloride. Since some of the detector tubes have cross-specificity for chemically-similar compounds, a positive test may not necessarily reflect the presence of one contaminant, but of several.

Level B protection will be required during sampling activities in the area of Landfill 1 and Landfill 3. Historical analytical data indicate repeated high concentrations of vinyl chloride in samples from monitoring wells HM-7, 21 and 50 which are located in these areas. Vinyl chloride is a proven huma carcinogen with a TLV of 1 ppm. Draeger tube tests for this contaminant will also respond to a number of other organic constituents which have been identified in high levels in this area. Since it is not feasible to positively detect precise concentrations of vinyl chloride using real-time

field detection methods, any vinyl chloride Drager tube readings above 10 ppm will have to be assumed to reflect vinyl chloride concentrations that require Level B protection.

Radian anticipates that EPA Level C protection will be adequate for scheduled activities at all other sites. However, the decision to select EPA Level C protection or Level B protection must be based upon the available historical analytical data from the area, as well as the data obtained from the air monitoring program. Upgrade to EPA Level B protection will be required when:

- o The total concentration of organic vapors in the air reaches 1000 ppm or more, or
- o The concentration of any individual contaminant is measured at ten times the Threshold Limit Value (TLV), or
- o Any team member experiences any sign of respirator failure, excessive cartridge loading, or contaminant breakthrough. This includes smelling or tasting contaminants in the mask, irritation of the nose or throat, or breathing difficulties. If at any time a team member experiences any of these symptoms, all personnel must leave the site at once until the cause can be identified.

6.2 Heat Stress Control and Monitoring Plan

Workers who wear protective clothing will be at increased risk of heat stress when temperatures are above 65°F and/or under heavy workload in protective clothing. The S fety Officer should operate a heat stress control and monitoring program to ensure that workers are:

- o Adhering to a work/rest schedule determined by the Project Director and dependent on work levels and outside temperatures.

- o Adequately replacing lost fluids.

- o Keeping body temperatures in a normal range.

6.2.1 Heat Stress Control

The Radian Project Officer will set work and break schedules depending on how heavy the work load is and the outside temperature in coordination with the drilling supervisor. Generally, workers conducting drilling activity in protective clothing need to break in the shade at least 10 minutes out of every hour during elevated temperatures. Rest time should also include fluid replacement with electrolytes (i.e., Gatorade or equivalent).

6.2.2 Heat Stress Monitoring

The on-site Safety Officer or representative should perform monitoring activities for heat stress when workers are using protective clothing in elevated temperatures. The heat stress monitoring plan includes:

- o Measurement of worker heart rate

- o Measurement of internal body temperature

- o Observation of the field team for signs and symptoms of heat stress

Heart rate (HR) will be measured 'y the radial pulse during 30 seconds as early as possible in the resting period. The HR at the beginning of the rest period should not exceed 110 beats per minute. If the HR is in

excess of the above value, the next work period will be shortened by 10 minutes while the length of the rest period stays the same.

Body temperature will be measured by using a "fever detector" strap that is placed on the forehead of the worker. Worker body temperature should not exceed 100°F. If the worker body temperature exceeds this value, the work period will be shortened by 10 minutes while the length of the rest period stays the same.

Workers that exhibit signs of heat stress should be allowed to rest until the signs are no longer observable. The signs of heat stress are:

- Pale, clammy skin progressing to hot, dry and red skin
- Profuse perspiration
- Cramps
- Headaches
- Nausea
- Fainting

6.3 Cold Injury Control and Monitoring Program

During this project, the Project Officer and drilling supervisor must be alert for the signs and symptoms of cold injury. Frostbite occurs when part of the body is affected by below-freezing temperatures. The flow of blood to the affected area(s) stops, and skin cells may be permanently damaged in severe cases. It is possible that sudden weather changes may occur during the scheduled field activities with freezing temperatures, high winds and wind-chill factors. Frostbite could easily result if proper precautions are not taken. The symptoms of frostbite are hard, pale, cold skin that becomes red and painful when thawed out. Hands, feet, nose and ears are most susceptible.

Hypothermia is caused by loss of body heat due to long exposure to cold. The victim becomes confused and eventually loses consciousness. He is cold and pale and his breathing and pulse may be very faint. Anyone suspected of having hypothermia should be removed to a medical facility immediately.

To avoid cold injury, it is important to wear several layers of warm clothes under a windproof outer garment such as the Tyvek coverall. Make sure that the face, hands, and feet are kept dry, warm and protected. The risk of cold injury increases dramatically with the wind chill factor.

If cold injury occurs:

- Get the victim medical attention as soon as possible;
- Provide shelter from wind and administer warm drinks;
- Cover frozen areas with additional clothing or blankets;
- Do not use direct heat or rub the frostbitten area(s);
- Encourage gradual, gentle movement, but do not allow the person to walk if the feet are frozen;
- Do not put frostbitten areas under warm or hot water.

7.0 WORK ZONES AND DECONTAMINATION PROCEDURES

To minimize the transfer of possible hazardous substances from the site, contamination control procedures are needed. Contaminants must be removed from clothing, personnel and equipment prior to relocation from a work zone.

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7.1 Work Zones

Prevention of exposure and spread of contamination will be controlled through the establishment of work zones. Three work zones will be used in this project; (1) Exclusion Zone and (2) Decontamination Zone and (3) Support Zone.

7.1.1 Exclusion Zone

The Exclusion Zone is the area where disturbance activities (monitor well installation or coring activity) are conducted and where contaminants may be present. Only properly trained individuals who are correctly dressed will be allowed to enter and work in this zone.

7.1.2 Decontamination Zone

The Decontamination Zone is the area where personnel and equipment are cleaned before moving to another part of the site.

Decontamination Zones will be set up in a concentric circle around the boreholes as site conditions dictate. Some areas will be confined by buildings and other obstructions which will limit the size and shape of the exclusion and decontamination zones. As site conditions will allow, decontamination operations will be conducted in an area no closer than 25 feet from the borehole, and within a 50 foot radius of the borehole.

7.1.3 Support Zone

The Support Zone is the area where the field team will reside when not performing site work. This area is the break area, eating area, storage area, and staging area. It is extremely important to locate this Support Zone in an area that is known to be free of contamination and upwind as practical.

7.2 Decontamination Procedures

Personal protective equipment and drilling and sampling equipment can become contaminated in a number of ways including:

- Contacting vapors, gases, mists, or particulates in the air
- Being splashed by materials while sampling or opening containers
- Walking through puddles of liquids or on contaminated soil
- Using contaminated equipment or instruments

Protective clothing and respirators help prevent the wearer from becoming contaminated, but these items may themselves become contaminated during work. The use of proper decontamination procedures will ensure that contaminants are not spread to clean areas, such as the support zone, where unsuspecting personnel would be exposed to hazard. Therefore, prior to leaving the decontamination zone, all spent garments, towels, gloves, paper, etc., will be disposed of in a 55-gallon drum provided for this purpose. All other reusable items such as respirators and hard hats suspected of being contaminated will be left on a clean surface (table) in the decontamination zone prior to moving into the support zone.

7.2.1 Equipment Decontamination Procedures

Equipment will be decontaminated by detergent washing and clean water rinsing all equipment that is not water sensitive. Such equipment includes:

- Personal protective gear, such as respirators and safety goggles

- o All sampling equipment such as spades, shovels, the outside of sample containers and notebooks, geological surveying equipment, logging cables, and incidental equipment that is contaminated during the course of work.

- o Formation samplers such as split-spoons and Shelby tubes will be decontaminated additionally with clean water, methanol and distilled water rinses.

7.2.2 Drilling Rig Decontamination Procedures

The drilling rigs will be steam cleaned after contacting soils or liquids suspected of being contaminated. An area for decontamination will be determined in coordination with the Base Bioenvironmental and Civil Engineers. Attention should be paid to the following procedures to decontaminate the equipment correctly and safely.

- o All steam cleaning personnel will wear goggles at all times. No exceptions will be permitted.

- o Storage of the fuel for the steam cleaner should be in a safe place, away from ignition sources.

- o If the steam cleaner is operated with electricity, provisions will be made to keep the electrical cord up off the wet ground.

- o Steam clean (with detergent solution) all drilling flights and pipe that have contacted soils or liquids. The drilling equipment should be laid on pallets to avoid contaminated mud, dirty pavement or other unclean equipment.

- o Full personal protection is required when performing decontamination on the drilling equipment.

8.0 EMERGENCY RESPONSE AND COMMUNICATION PLAN

The objective of the emergency response and communication plan is to ensure that effective actions are implemented in a timely manner to minimize and control the effects of adverse events (fires, injuries, equipment failures, etc.). The following subsections describe the basic emergency response plans required for the field investigation.

8.1 Emergency Medical Response

Before beginning site activities, make sure that the each field team member knows where the nearest emergency medical facility is and how to get there. Locate the closest telephone.

Next, post, in the Support Zone, the telephone number of the local fire, police and ambulance service and make sure that the field team knows how to call for help in an emergency. The closest hospital is a base hospital.

Next, make sure that the field team is aware of the location of a first aid kit. The Project Officer should be prepared to handle minor injuries and perform CPR (if trained).

Depending on the severity of the medical emergency, the Radian Project Officer and drilling supervisor will be responsible for:

- o Removing the injured or ill person from the hazardous area
- o Treatment of minor injuries
- o Transportation of the injured worker to a medical facility
- o Placing the request for outside emergency medical assistance

Prior to starting work on site, the Safety Officer or representative will brief emergency medical personnel who will respond to the site with the following information:

- o Number of site workers
- o Hazards involved with site work
- o Anticipated types and severities of injuries
- o Recommended treatment practices (if available)

8.2 Fire Emergency Procedures

The threat of fire on this particular project is considered slight, due to the fact that the contaminated material would be aqueous or solid in nature. Fire hazards will however exist in the following activities:

- o Equipment re-fueling
- o Steam cleaning fuel storage and re-fueling activities
- o Any welding activities
- o Any solvents that are used in decontamination

The Project Officer should check to see that each vehicle and drilling rig fire extinguisher is appropriate for the fire hazard presented by this project. Generally, Type A, B, C extinguishers will be appropriate.

Immediately upon discovery of any fire, the Radian Project Officer will be notified and attempts will be made to extinguish the fire. All large fires will require the help of the fire department and the Radian Project Officer should call for help at the earliest possible time. Be aware that toxic products produced in a fire situation can be very dangerous and the fire department personnel should be briefed on these hazards before starting work on the site.

The Radian Project Officer will direct precautionary actions on site after notifying the fire department. Th se precautionary actions include:

- o Notification of all site personnel that a fire exists and to return to the support area

- o Immediate shut-down of site activities

- o Accounting for all site workers

- o Site evacuation if necessary

8.3 Emergency Communications

The Radian Project Officer should make sure that he or she knows the emergency telephone number of the following agencies:

- o Base Safety Office
- o Base Medical Station
- o Local Fire Department
- o Local Police Department
- o Nearest Local Hospital Facility
- o Ambulance service

9.0 RECORDKEEPING PROCEDURES

To document the safety and health program for the AF Plant 4 investigation, the Radian Project Officer needs to keep accurate records of the following:

- o Documents certifying that each member of the field team has completed an occupational medical examination.

- o Certification of the successful completion of fit testing for respirators.

- o Records of the analytical results of the employee exposure monitoring program.

- Signed certificates by the field team that they have read and understand the safety and health requirements contained in this plan.

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APPENDIX C

Quality Control Plan

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212-027-27 Delivery Order No. 27

APPENDIX C

INSTALLATION RESTORATION PROGRAM

PHASE II-CONFIRMATION/QUANTIFICATION

STAGE 1

QUALITY CONTROL PLAN

FOR

AIR FORCE PLANT 4

FORT WORTH, TEXAS

Prepared by:

Radian Corporation

Under Contract

F33615-83-D-4001

Submitted to:

UNITED STATES AIR FORCE
Occupational and Environmental Health Laboratory
Brooks AFB, Texas 78235

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1.0 INTRODUCTION

The field investigation at AF Plant 4 will generate a large number of soil and water samples for chemical analyses. The analytical results will then used to interpret the impact of a particular waste site upon the local hydrogeologic system. Since each analysis forms a foundation for interpretation, it is important that each sample is representative of a particular situation.

A quality control (QC) plan provides guidelines for sample collection, preservation, and tracking. Adherence to the QC plan ensures that sample integrity is maintained and that no contamination or cross-contamination occurs.

This QC plan describes the methods for collection of soil and water samples. Methods of preservation, shipping and administrative controls are also discussed.

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2.0 QUALITY CONTROL PROCEDURES FOR SOIL ANALYSIS

As required by the Statement of Work, soil samples will be collected at Air Force Plant 4. Details of the analytical program are summarized in Table 2-1. Sample collection procedures are described in Table 2-2. Quality control procedures for sample collection and analysis are discussed below.

2.1 Collection of Soil, Sediment and Tissue Samples

Quality control procedures for soil sampling will be an integral part of the sampling methodology. These procedures focus upon ensuring the collection of representative samples which are free from external contamination. Documentation and chain-of-custody procedures are also an important part of the sample collection QC effort, which includes the following procedures:

- o Split-spoon and Shelby tube sampling will be used to obtain representative samples from depth specific points during drilling operations, as opposed to sample cuttings which may originate at different points and be cross-contaminated.

- o During the drilling, the on-site geologist will ensure that cuttings coming to the surface on the auger flights are accurately described. This will serve as a general log to be confirmed by split-spoon samples.

- o The split-spoon or Shelby tube sampler will be cleaned between each sampling to prevent cross-contamination of the samples, in accordance with the Safety Plan.

- o All samples will be split, with one set sent to OEHL. An additional 10% will be split and run in duplicate by RAS as an

TABLE 2-1. ANALYTICAL METHODS, DETECTION LIMITS AND NUMBER OF SAMPLES FOR PHASE II STAGE 1 INVESTIGATION AT AIR FORCE PLANT 4, TEXAS

Parameter	Method	Detection Limit	Samples	QA/QC[b]	Total Samples
Chromium	EPA 218.1	50 ug/L 5 ug/g	28G	3	33
Purgeable Organics	EPA 601/602 or 8010/8020	a	106G 23S 10W	49	188
Base Neutrals and Acid Extractibles	EPA 625	c	84G 4S 10W	10	108
Heavy Metals	FR, Vol 44 3 Dec 1979	d	89G 12S 10W	12	123
SUSPECTED HAZARDOUS WASTES:					
EP Toxicity	EPA 1310	c	20G 20S	4	44
Ignitability	40 CFR 261.21	e	20S	2	22
Purgeables	EPA 624	c	30G 20S	5	55
HC Fuels	EPA 418.1		53G 22S	8	83
Oil & Grease (IR)	EPA 413.2	100 ug/L	43G 10S	6	64
pH	EPA 150.1	±0.1 unit			
MEK	EPA 8015		5G 2S	1	8
Specific Conductance	EPA 120.1	1 umho/cm			
Xylene (AVO)	EPA 8020	c	5G 2S	1	8

(Continued)

TABLE 2-1. (Continued)

NOTES (Table 2-1):

a. Detection limits for Purgeable Organic Compounds shall be as specified for the compounds by EPA Methods 601/602 and 8010/8020 (soils). These methods for purgeable organic compounds requires positive confirmation by a second gas chromatographic column. This must be done before reporting positive values. Second column confirmation is required when values exceed:

Benzene	0.7 ug/L
Carbon Tetrachloride	4.0 ug/L
1,2 Dichlorethane	0.1 ug/L
Methylene Chloride	4.0 ug/L
Tetrachloroethylene	4.0 ug/L
Trichloroethylene	1.0 ug/L
Vinyl Chloride	1.0 ug/L
Dichlorobenzene isomers	Sum greater than 10 ug/L
Any other organic	Greater than 10 ug/L.

Retention time on both columns must match before reporting positive value. If no match, it will be considered as interference.

If questions are encountered about certain contaminants, you may be asked to show both chromatograms used to rule out possible interference.

b. Includes 10% QA/QC for all samples and 25% second column analyses on EPA Methods 601, 602, 8010, and 8020.

c. Detection limits specified by the EPA or Standard method.

d. Heavy Metals:

Metal	ug/L of Leaching Solution
As	10
Ba	200
Cd	10
Cr	50
Pb	20
Hg	1
Se	10
Ag	10

e. Find if sample is ignitable at 140°F or below. If so, it is a hazardous waste.

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TABLE 2-2. FIELD COLLECTION OF SAMPLES

The following guidance is provided to field survey personnel to assist them in collecting, preparing and preserving samples.

Soil Sample Collection

Samples will be placed in containers as described below:

Analysis Required	Field Procedure
Purgeable Halocarbons, Aromatics and Purgeables (EPA 624/625 and 8010/8020)	Obtain a homogeneous sample and fill 2 each 40 ml VOA vials. Keep samples frozen, 0°C.
EP Toxicity > Ignitability >	Prepare a homogeneous soil mixture and fill a 1-quart glass jar.
All other parameters	Prepare a homogeneous soil mixture and fill each 1-pint glass jar. NOTE: One jar provides RAS with sufficient soil to perform any or all requested analyses. Keep samples frozen, 0°C.

Water Sample Collection

Analysis Required	Field Procedure
Purgeable Halocarbons, Aromatics and Purgeables (EPA 601/602 and 624)	Collect sufficient water and fill 4 each 40 ml VOA vials to the top (no air bubbles present). Cap and seal the vials. Aromatics may receive HCl to extend holding time. Keep samples chilled to 4°C.
Metals	Collect sufficient water and fill a 500 ml plastic bottle. Add 2 ml (1 plastic pipet full) of Nitric Acid to each bottle. Keep samples chilled to 4°C.
Oil and Grease, Petroleum HC, and Phenol	Collect sufficient water and fill a 1-quart glass bottle nearly to the top. Add 2 ml (1 plastic TOC, pipet full) of Sulfuric Acid to the bottle. Keep samples chilled to 4°C.
Base/Neutrals and Acid Extractables (EPA 625) and PCBs (EPA 608)	Collect sufficient water and fill an amber glass 1-quart jar. Keep sample chilled to 4°C.
pH Conductance	Measure on-site.

internal QC check. Also, up to 25% of all purgeable organic samples will be subject to second column confirmation analysis.

- After sample collection, each sample will be logged into a master sample logbook (bound, paginated, laboratory notebook) which as a minimum indicates the date and time of sample collection, sample type, and initials of the person who collected the sample.

- Soil and sediment samples will be preserved at 0°C until analyzed.

- Chain-of-custody forms (Figure 2-1) will be used to document all Radian and USAF transfers of sample possession from initial preparation of the sample container to final disposition of the sample.

- Samples shipped to OEHL require additional information which must accompany each sample. Table 2-3 lists the required information, much of which is provided on the sample label. Figures 2-2 and 2-3 show Air Force forms that also need to accompany soil and water samples, respectively. Instructions completing these forms are provided after the figures.

2.2 Special Quality Control Measures for Soil Samples

For most analytical methods, RAS' routine QC procedures include:

- Daily calibration with QC check,
- 10% duplicate analyses, and
- 10% spiked sample analyses.

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Figure 2-1

CHAIN OF CUSTODY RECORD

Field Sample No. ______________

Company Sampled/Address ______________________________
Sample Point Description ______________________________

Stream Characteristics:
Temperature ______________ Flow ______________ pH ______________
Visual Observations/Comments ______________________________
____

Collector's Name ______________ Date/Time Sampled ______________
Amount of Sample Collected ______________________________
Sample Description ______________________________
Store at: ☐ Ambient ☐ 5°C ☐ −10°C ☐ Other ______________

☐ Caution - No more sample available ☐ Return unused portion of sample ☐ Discard unused portions

Other Instructions - Special Handling - Hazards ______________________________
____
____

Hazardous sample (see below) ☐ Non-hazardous sample

Toxic	☐ Skin irritant	☐ Flammable (FP< 40°C)
Pyrophoric	☐ Lachrymator	☐ Shock sensitive
Acidic	☐ Biological	☐ Carcinogenic - suspect
☐ Caustic	☐ Peroxide	☐ Radioactive

☐ Other ______________________________

Sample Allocation/Chain of Possession:
Organization Name ______________________________
Received By ______________ Date Received ______________ Time ______________
Transported By ______________ Lab Sample No. ______________
Comments ______________________________
Inclusive Dates of Possession ______________________________

Organization Name ______________________________
Received By ______________ Date Received ______________ Time ______________
Transported By ______________ Lab Sample No. ______________
Comments ______________________________
Inclusive Dates of Possession ______________________________

Organization Name ______________________________
Received By ______________ Date Received ______________ Time ______________
Transported By ______________ Lab Sample No. ______________
Comments ______________________________
Inclusive Dates of Possession ______________________________

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TABLE 2-3. INFORMATION TO ACCOMPANY SAMPLES FOR CHEMICAL ANALYSES

1. Installation name (base)
2. Purpose of sample (analyte)
3. Sample Number (on containers)
4. Source/location of sample
5. Contract Task Number and Title of Project
6. Method of collection (i.e., bailer, suction pump, air-lift pump, split spoon, etc.)
7. Volumes removed before sampling (ground-water samples only)
8. Special conditions (use of surrogate standard, special nonstandard preservation, etc.)

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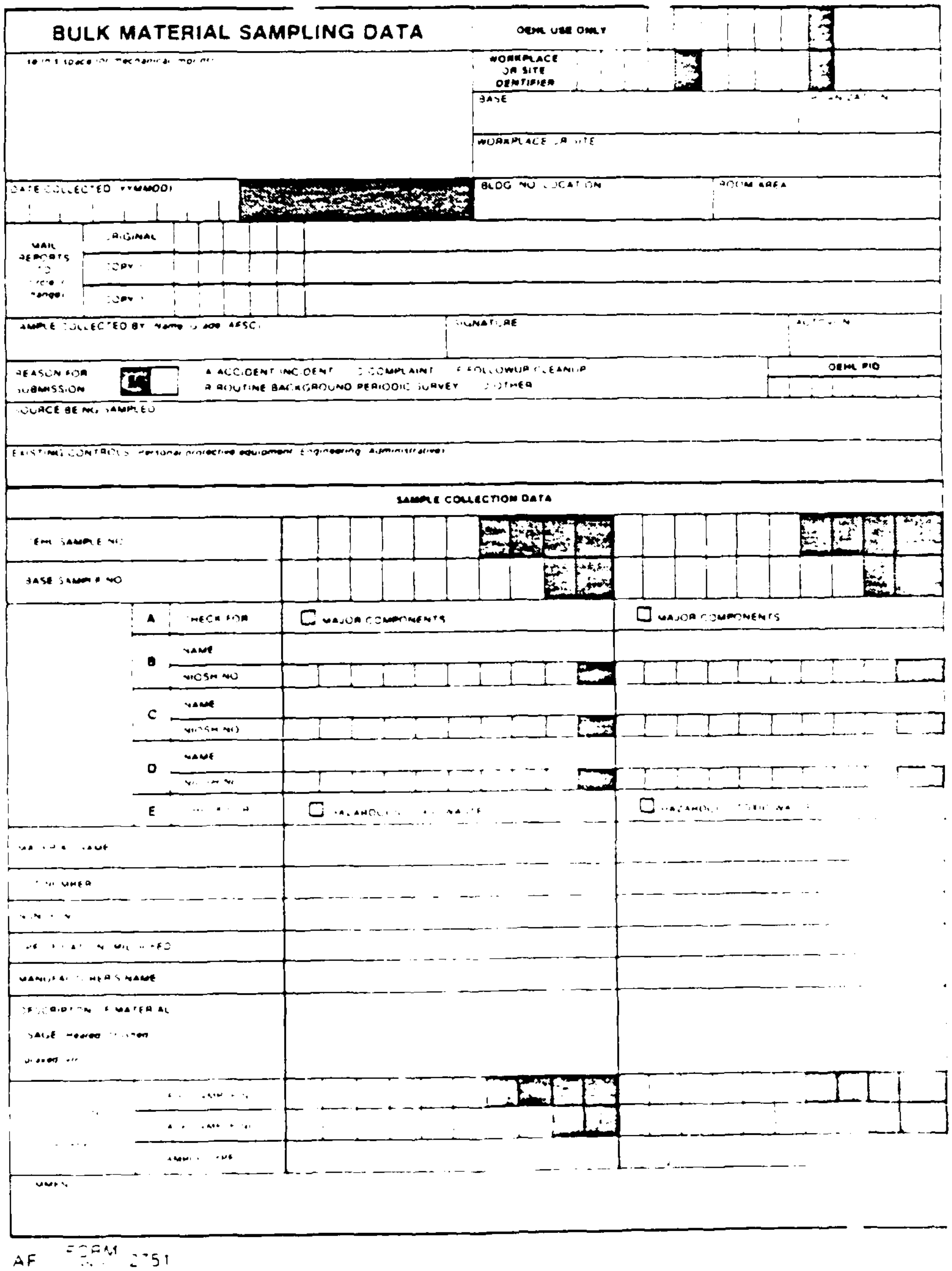

BULK MATERIAL SAMPLING DATA

OEHL USE ONLY

WORKPLACE OR SITE IDENTIFIER

BASE

WORKPLACE OR SITE

DATE COLLECTED (YYMMDD)

BLDG NO LOCATION

ROOM AREA

MAIL REPORTS TO

ORIGINAL

COPY

COPY

SAMPLE COLLECTED BY (Name, Grade, AFSC)

SIGNATURE

REASON FOR SUBMISSION

A ACCIDENT INCIDENT

B ROUTINE BACKGROUND PERIODIC SURVEY

C COMPLAINT

E FOLLOWUP CLEANUP

OTHER

OEHL PID

SOURCE BEING SAMPLED

EXISTING CONTROLS (Personal protective equipment, Engineering, Administrative)

SAMPLE COLLECTION DATA

OEHL SAMPLE NO

BASE SAMPLE NO

A CHECK FOR — MAJOR COMPONENTS — MAJOR COMPONENTS

B NAME / NIOSH NO

C NAME / NIOSH NO

D NAME / NIOSH NO

E — HAZARDOUS WASTE — HAZARDOUS WASTE

MANUFACTURER'S NAME

DESCRIPTION OF MATERIAL

AF FORM 2751

Figure 2-2. AF Form 2751 Used for Soil Sample Shipping.

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ENVIRONMENTAL SAMPLING DATA		OEHL USE ONLY	
Use this space for mechanical imprint		SAMPLING SITE IDENTIFIER (AFR 19-7)	
		BASE WHERE SAMPLE COLLECTED	
		SAMPLING SITE DESCRIPTION	
DATE COLLECTION BEGAN (YYMMDD)	TIME COLLECTION BEGAN (24 hour clock)	COLLECTION METHOD ☐ GRAB ☐ COMPOSITE ______ HOURS	
MAIL REPORTS TO (circle if changed)	ORIGINAL		
	COPY 1		
	COPY 2		
SAMPLE COLLECTED BY (Name, Grade, AFSC)		SIGNATURE	AUTOVON
REASON FOR SUBMISSION	A-ACCIDENT/INCIDENT R-ROUTINE/PERIODIC	C-COMPLAINT N-NPDES	F-FOLLOWUP/CLEANUP O-OTHER (specify)
BASE SAMPLE NUMBER		OEHL PID	

ANALYSES REQUESTED (check appropriate blocks)

GROUP A		Hardness	00900	Residue, Settleable	50086	GROUP I	
Ammonia	00610	Iron	01045	Residue, Volatile	00505	Bromoform	32104
Chemical Oxygen Demand	00340	Lead	01051	Silica	00955	Bromodichloromethane	32101
Kjeldahl Nitrogen	00625	Magnesium	00927	Specific Conductance	00095	Carbon Tetrachloride	32102
Nitrate	00620	Manganese	01055	Sulfate	00945	Chloroform	32106
Nitrite	00615	Mercury	71900	Sulfite	00740	Chloromethane	34418
Oil & Grease	00560	Nickel	01067	Surfactants -MBAS	38260	Dibromochloromethane	32105
Organic Carbon	00680	Potassium	00937	Turbidity	00076	Methylene Chloride	34423
Orthophosphate	00671	Selenium	01147			Tetrachloroethylene	34475
Phosphorus, Total	00665	Silver	01077			1,1,1-Trichloroethane	34506
		Sodium	00929	GROUP H		Trichloroethylene	39180
GROUP D		Thallium	01059	BHC Isomers	39340	Trihalomethanes	82080
Cyanide, Total	00720	Zinc	01092	Chlordane	39350	PCBs	39516
Cyanide, Free	00722			DDT Isomers	39370		
				Dieldrin	39380		
GROUP E		GROUP G		Endrin	39390		
Phenols	32730	Acidity, Total	70508	Heptachlor	39410		
		Alkalinity, Total	00410	Heptachlor Epoxide	39420		
GROUP F		Alkalinity, Bicarbonate	00425	Lindane	39782		
Antimony	01097	Bromide	71870	Methoxychlor	39480		
Arsenic	01002	Carbon Dioxide	00405	Toxaphene	39400		
Barium	01007	Chloride	00940	2,4-D	39730	ON SITE ANALYSES	
Beryllium	01012	Color	00080	2,4,5-TP Silvex	39760	Parameter	Value
Boron	01022	Fluoride	00951	2,4,5-T	39740	Flow 00050	mgd
Cadmium	01027	Iodide	71865			Chlorine, Total 50060	mg/l
Calcium	00916	Odor	00086			Dissolved Oxygen 00300	mg/l
Chromium, Total	01034	Residue, Total	00500			pH 00400	units
Chromium VI	01032	Residue, Filterable (TDS)	70300	GROUP J		Temperature 00010	C
Copper	01042	Residue, Nonfilterable	00530	Sulfides	00745		

COMMENTS

AF FORM JAN 81 2752

Figure 2-3. AF Form 2752 Used for Sample Shipping.

INSTRUCTIONS FOR COMPLETING AF FORM 2751, BULK MATERIAL SAMPLING DATA

The purpose of this form is to request bulk material analyses from the USAF Occupational and Environmental Health Laboratory (USAF OEHL). Major chemical components, specific components or hazardous/toxic waste characteristics can be requested.

1. Identification Data. Plastic embossed cards for recording identification data may be used in lieu of the following handwritten entries:

a. Workplace Identifier (WI). Enter code for Workplace Identifier (see Attachment 1 for codes).

b. Base. Enter name of base where workplace is located.

c. Organization. Enter name of organization.

d. Workplace. Enter name of workplace.

e. Building Number/Location. Enter building number or location.

f. Room/Area. Enter specific part of workplace being sampled (for example, Room 26, degreaser, layup table). If sample pertains to entire workplace, enter "NA" (not applicable).

2. Date Collected. Enter date sample collected (for example, if Jan 14, 1981, enter 81/01/14).

3. Mail Reports To. Enter mailing addresses where analysis results will be sent. Enter four-digit base code in small boxes (same code as first four digits of Workplace Identifier if same base). Enter unit designation, office symbol, base, state, and ZIP code.

4. Sample Collected By. Enter name (last name only), grade and AFSC of individual collecting sample.

5. Signature. Enter signature of individual collecting sample.

6. AUTOVON. Enter AUTOVON number of responsible individual who can answer questions from the laboratory concerning the sample.

7. Reason for Submission. Enter code (in the box to the right of shaded "M") indicating reason for submitting sample. For samples involving accidents, contact USAF OEHL for special OEHL PID code to be entered in shaded boxes.

8. Source Being Sampled. Enter description of source being sampled (for example, slop tank, solvent tank, deteriorating ceiling) and the nature of the operation/task being performed.

9. Existing Controls. Enter controls in use at time of survey, including observations as to their effectiveness.

10. Sample Collection Data. Analyses can be requested in this section for a maximum of two samples.

a. OEHL Sample Number. Leave blank.

b. Base Sample Number. Enter eight-digit coded base sample number for each sample. See Attachment 3 for codes.

c. Analyses Requested. Check "major components" box if chemical composition is requested. Enter name and NIOSH number if analyses of specific components are requested. NIOSH numbers are provided in the USAF OEHL Recommended Sampling Procedures next to each compound name (for example, for dimethylamine, enter IP 87500). Check "hazardous/toxic waste" box if these characteristics are requested.

d. Material Name. Enter name as it appears on the container.

e. Lot Number. Enter manufacturer's lot number.

f. NSN (FSN). Enter national (or federal) stock number of material.

g. Specification (MIL or FED). Enter military or federal specification number.

h. Manufacturer's Name. Enter complete name, address and telephone number (if available) of the material manufacturer.

i. Description of Material Usage. Describe how the material is used in the workplace. For wastes, describe how they are stored.

j. Supporting Samples. When air samples are collected in conjunction with the bulk sample(s), enter base air sample number and type to ensure they are simultaneously processed at the USAF OEHL. Leave OEHL Sample Number blank.

k. Comments. Record any additional information which the laboratory may need. Also include name of any laboratory personnel consulted on sampling strategy.

11. Submit original form with sample(s) being analyzed. File copy in Tab D (Chemical Exposure Data) of case file with analytical results stapled to it.

INSTRUCTIONS FOR COMPLETING AF FORM 2752, ENVIRONMENTAL SAMPLING DATA

The purpose of this form is to record environmental and drinking water sampling information. The form will be used for submitting environmental and drinking water samples (except radiological samples) to the USAF Occupational and Environmental Health Laboratory (USAF OEHL). Use AF Form 2753 for radiological sampling data.

1. Identification Data. Plastic embossed cards for recording identification data may be used in lieu of the following handwritten entries:

   a. Sampling Site Identifier. Enter code for Sampling Site Identifier (see page 3).

   b. Base. Enter name of base where sample is collected.

   c. Sampling Site Description. Enter name of sampling site.

2. Date Collection Began. Enter date sample collection began (e.g., if Jan 14, 1981, enter 81/01/14).

3. Time Collection Began. Enter time (24-hour clock) sample collection began.

4. Collection Method. Check whether sample was a grab sample or a composite sample. If a composite sample, enter number of hours from beginning to the completion of compositing.

5. Mail Reports To. Enter four-digit base code in small boxes (same code as first four digits of environmental identifier if same base). Enter mailing addresses where analysis results will be sent. Include unit designation, office symbol, base, state, and ZIP code.

6. Sample Collected By. Enter name (last name only), grade and AFSC of individual collecting sample.

7. Signature. Enter signature of individual collecting sample.

8. AUTOVON. Enter AUTOVON number of responsible individual who can answer questions from the laboratory concerning the sample.

9. Reasons for Submission. Enter code (in the box to the right of shaded "E") indicating reason for submitting sample.

10. Base Sample Number. Enter eight-digit coded base sample number for each sample. See pages 4-5.

11. OEHL PID. Leave blank.

12. Analysis Requested. Check the block to the left of the analyses desired. For parameters not listed, enter parameter name and number in the blank spaces provided under the appropriate preservation group. Continue in the Comments Section if required.

13. On-Site Analyses. Enter results of any on-site analyses. For parameters not listed, enter parameter name, number, value and unit in the blank spaces provided.

14. Preserve a one liter (one quart) sample as shown in page 7 for each group in which an analysis is requested.

15. Submit one copy of the completed form in a waterproof envelope with the sample to USAF OEHL/SA, Building 140, Brooks AFB TX 78235.

THE SAMPLING SITE IDENTIFIER

1. All environmental monitoring and drinking water sampling sites must be identified in a standardized manner. The sampling site identifier will be used for local identification purposes and will be the primary identifier for environmental data stored in a central Automatic Data Processing (ADP) repository.

2. The sampling site identifier is nine alphanumeric characters made up of the installation code, followed by the sampling site type code and the sampling location number.

a. Installation Code. The four-digit number now used for the film dosimetry program with a zero prefix (available from project monitor or base bioenvironmental engineer).

b. Sampling Site Type. A two-letter code to identify the source of the sample (see para 5 of this attachment for the complete list).

c. Sample Location Number. A three-digit number assigned locally.

3. The code formed when the three elements are combined is unique for a particular sampling point. If the sampling location is taken out of service, destroyed or no longer used, the code will not be reassigned to another sampling site nor used again.

4. The new code will look like this:

Installation Code	Sample Type	Sample Location
0 1 2 3	AB	4 5 6

5. Sample Type Codes:

Sampling Site Type	Code
Air	AO
Nonpotable water, source (effluent)	NS
Nonpotable water, process	NP
Nonpotable water, ambient	NA
Potable water, distribution system	PD
Potable water, ground water (untreated)	PG
Potable water, surface water (untreated)	PS
Potable water, other	PO
Solid	SO

CODED BASE SAMPLE NUMBER

This section contains accepted environmental sampling methods recommended by the USAF OEHL. The basis for any monitoring program rests upon information obtained from sampling. Improper sampling can negate even the most careful and accurate work performed by the remainder of the monitoring team. Therefore, the proper selection, collection, identification and shipment of environmental samples are paramount for a successful monitoring program. (General instructions for packaging and shipping samples are contained in Section V). Additional information can be obtained from:

USAF OEHL/ECA AUTOVON 240-2891 or (512) 536-2891
USAF OEHL/ECW AUTOVON 240-3305 or (512) 536-3305
USAF OEHL/ECE AUTOVON 240-3667 or (512) 536-3667

ASSIGNMENT OF BASE SAMPLE NUMBERS

Environmental samples that are collected at base level must be assigned a sample number, regardless of whether they are analyzed locally or at a central laboratory such as the USAF OEHL. This coded sample number will enable the analysis results to be ultimately stored in and retrieved from a central data repository. A sample number code consists of eight digits. The first two digits classify the sample as to the method and type of sample. The next two digits identify the calendar year that the sample was taken and the last four digits identify the locally assigned sample number, progressing in numerical sequence from sample number 0001 to sample number 9999. Sample number codes follow:

a. First 2 digits

(1) Digit #1 -

Sample Method	Code
Grab Sample	G
Composite Sample	C

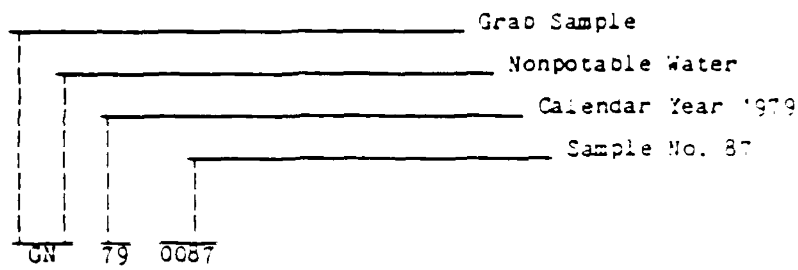
(2) Digit #2 -

Sample Type	Code
Nonpotable	N
Potable Water	P
Residue (Incinerator Ash)	[illegible]
Sludge (Wet or Dry)	L
Soil	S
Unclassified	C
Vegetation	V

b. Next 2 digits - Code for sample year using last two numbers of calendar year in which sample was taken. Example: Code for CY 1981 is 81.

c. Last 4 digits - Code for locally assigned, numerically sequenced sample number. Example: Code for thirteenth sample taken during a calendar year is 0013.

Completed Base Sample Number. To illustrate a completed code, consider an environmental water sample taken to characterize storm water runoff. The sample was a grab sample taken from a storm drain. Eighty-six other samples had already been taken at the base that year (CY 1979). The sample would be:



USAF OEHL WORK CENTER CODES

	Analysis of Industrial Hygiene Samples	
1XX	Liquid Media or Eluent for Tube Analysis	
2XX	Liquid Media or Eluent for Pesticide Type Analysis	
3XX	Eluent or Solvent for Metals Analysis	
4XX	Collection Media Colorimetric Analysis	
5XX	Media for Gravimetric/Physical Observations	
6XX	Media for Volumetric/Electrometric AN	
7XX	Media for Liquid Chromatography	
9XX	Special Modification	
1XXX	Special Analysis (Bulk Industrial Products)	
9XXX	Analysis of Biological Materials	
1XXXX	Analysis of Water or Soil (Environmental) Samples	
	10100-10199	A Preservation Group
	10300-10399	D Preservation Group (Cyanides)
	10400-10499	E Preservation Group (Phenols)
	10500-10599	F Preservation Group (Metals)
	10600-10699	G Preservation Group (Unpreserved)
	10600	J Preservation Group (Sulfides)
	10700-10799	H Preservation Group (Pesticides)
	10800-10899	T Preservation Group (Trace Organics)
2XXXX	Radioassay of Materials	

In addition to observing all quality control measures outlined in the standard analytical methods (EPA, ASTM, etc.) used in this study, second column confirmation may be required for some analyses. Specifically, in soil samples where one or more of the EPA Method 8010 or 8020 compounds is detected at concentrations exceeding the values of Note "a" on Table 2-1, second column confirmation is required.

Retention times in both columns must match before a positive value is reported for any of these compounds. If the retention time in either column does not match the established value, the results will be interpreted as an interference.

As a further QC measure for metals analyses, calibration curves will be generated daily for each metal species analyzed using a reagent blank and a minimum of three upscale concentrations. A calibration curve will be considered acceptable if the correlation coefficient is $\geq$0.995. Continuing calibration checks are made every ten samples. These procedures are based on recommendations provided in the EPA 200 Series Methods.

3.0 QUALITY CONTROL PROCEDURES FOR GROUND-WATER AND SURFACE WATER SAMPLING AND ANALYSIS

Drilling, monitor well installation, and well development will be conducted early in the field program at AF Plant 4. Sampling of wells will occur after drilling activities are completed. Ground-water and surface water samples will be analyzed for the constituents identified on Table 2-1. Quality control procedures for sample collection and analysis are described below.

3.1 Sampling Quality Control for Ground-Water and Surface Water Samples

Quality control efforts associated with ground-water and surface water sampling are an integral part of the monitor well development and sampling methodology. These procedures focus upon ensuring that the samples are representative of the specified depth and as free as possible from external and/or cross-contamination. Examples of the QC aspects of the water sampling efforts include the following:

- Ground-water levels will be measured to the nearest 0.01 foot and recorded before any ground-water disturbances.

- Initially, after completion, all wells will be pumped or bail-developed to remove all fines within the well.

- All Upper Zone will be purged using a PVC bailer or dedicated pump. All Paluxy wells will be pumped. Purging will continue until the pH and specific conductance of the ground water stabilizes or until three well volumes of water have been removed.

- Following purging, wells will be allowed to recover prior to sampling.

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- A Teflon bailer will be used for Upper Zone ground-water sampling. Should depth-discrete samples be desired, they may be obtained utilizing a Kemmerer-type sampler constructed of inert materials to minimize the potential for sample contamination. The Paluxy wells will be sampled via installed sampling taps.

- Where possible, upgradient wells will be sampled first in order to minimize possible transfer of any contaminants among the wells.

- Surface waters will be sampled with a ball-valve bailer or Kemmerer sampler to obtain representative depth-stratified samples. Care will be exercized to avoid stirring up sediment which might affect the analytical results.

- Samples must be transferred to sample jars with a minimum of agitation and disturbance in order to prevent stripping of any volatile organics from the water sample.

- All sampling equipment will be thoroughly cleaned and/or replaced prior to the start of work and between sampling locations.

- A sufficient volume of water will be collected at each sampling point so that samples can be split with OEHL and a replicate of each can be retained by Radian Analytical Services for confirmation of initial analytical results or for subsequent detailed analyses.

- All samples will be chilled to 4°C during transportation and storage.

- In addition to the number of samples collected for analyses, the Radian hydrogeologist will also collect 10 percent additional duplicate samples for QA/QC purposes as well as an additional 25 percent of purgeable organic samples for second column confirmation. Sample totals listed in Table 2-1 include duplicates. Duplicates will be collected as two water samples from the same bailer and/or two separate bails from the same well. These will help determine any sampling and analytical variability.

- Trip and field blanks will be prepared carried to the field during sampling, and accompany the sample shipment to RAS.

3.2 Chain of Custody

Chain of custody documentation must accompany all samples. The chain of custody records will contain, at a minimum, the following information:

- Time, date, and location of sampling, and name of person performing sampling;

- Sample identification number, depth, and type of sample;

- Conditions encountered during well evacuation and water sample collection;

- The signature of the responsible on-site sampler, and the time and date he/she relinquished the samples for transport to RAS.

3.3 Special Quality Control Measures for Water Samples

For most analytical methods, RAS' routine QC procedures include:

- o Daily calibration with QC check,
- o 10% duplicate analyses, and
- o 10% spiked analyses.

In addition to observing all quality control measures outlined in the standard analytical methods (EPA, ASTM, etc.) used in this study, second column confirmation will be required for positive identification of EPA 601 or 602 compounds. If these compounds are detected on the first run at concentrations exceeding the values of Note "a" on Table 2-1, a second column will be used. The retention time for the second column must also match the established value before the presence of the contaminant in question is confirmed. If the retention time for the second column does not match, the results will be interpreted as an interference.

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